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MSC-00116

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA PROGRAM APOLLO WORKING PAPER

# FLOW CHARACTERISTICS OF THE LUNAR MODULE WATER MANAGEMENT SYSTEM





MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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# FLOW CHARACTERISTICS OF THE LUNAR MODULE WATER MANAGEMENT SYSTEM

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# FLOW CHARACTERISTICS OF LUNAR MODULE WATER MANAGEMENT SYSTEM

By R. Trabanino

## SUMMARY

In-house tests were conducted on the lunar module water management system simulator to determine the flow characteristics of the water management system from the tanks through the firefighting/water dispenser interface. The system pressure losses and flow rates were measured along the water delivery lines downstream of the descent and ascent water storage tanks, at various tank pressures, with the water dispenser/fire extinguisher attached to the end of the flex hose assembly. These are the lines confined to the water dispenser and portable life support system. The test program described in this document presents the results of the tests carried out to determine the flow characteristics of the lunar module water management system and provides basic flow data for additional testing of the fire fighting system.

## INTRODUCTION

At present, Lunar Module 3 (LM-3) and subsequent LM vehicles are equipped with onboard firefighting equipment, accomplished by incorporation of a fire extinguishing water gun. This fire extinguishing gun is a modified version of the basic LM water dispenser and is expected to provide the LM with an effective fire fighting capability. The Whirlpool Corporation, under the supervision of the Crew Systems Division (CSD), redeveloped the water dispenser into a water dispenser/fire extinguisher gun (fig. 1), incorporating in its design a fire nozzle developed by the Structures and Mechanics Division (SMD).

The water dispenser draws its supply of water from the LM water management system (WMS), designed and built by the Grumman Aircraft Engineering Corporation (GAEC). The WMS and a qualification unit of the water dispenser/fire extinguisher comprised the test apparatus (fig. 2).

Since the flow characteristics of the LM WMS had not previously been experimentally established, SMD conducted this test series to record accurately the system water flow under conditions simulating those to be encountered in flight. Pressure losses and flow rates were monitored at points along the delivery lines downstream from the descent and ascent stage water tanks as the tank pressures dropped from their original predetermined charge pressures to the minimum acceptable pressures. The performance criterion was a uniform flow at sufficient pressure at the extinguisher outlet. Since this test program was concerned only with flow characteristics and did not undertake an evaluation of the actual fire fighting effectiveness of the system, further testing is necessary to establish flight qualification of the fire fighting system.

The author wishes to acknowledge the valuable assistance in preparing this report given him by Donald F. Price, Aerospace Technologist of LM Environmental Control System, Crew Systems Division, Manned Spacecraft Center (MSC), and by David R. Westrich, Student Trainee of Structural Test Section, Structures and Mechanics Division, MSC.

## DESCRIPTION

### Test Article

The test article consisted of the LM water management system simulator (part no. LDW 430-51230), the flex hose assembly (LDW 430-51236-1), and the water dispenser/fire extinguisher (Whirlpool part no. 14-0131). The simulator was composed of descent stage (D/S) and ascent stage (A/S) tanks identical to those in the flight vehicle, water lines which approximate vehicle lines in length, and a Hoke valve for flow regulation (the function of the Hoke valve is described under the section entitled "Test Procedures"). This valve and some of the line connections have no equivalent on the flight vehicle. Figure 3 shows a schematic of the system.

### Test Equipment

The test equipment used consisted of the following ground support equipment:

1. Water transfer unit (LSC 430-94119)
2. Water servicing manifold (LSC 430-54340)
3. Water servicing vacuum pump (LSC 430-54320)
4. Water hoses (LSC 430-54379)

The four items mentioned above comprise the unit commonly known as the water charging unit. This unit is the responsibility of GAEC; hence, all water loading of the tanks at MSC was accomplished under GAEC supervision and procedures.

## Instrumentation

In addition to the ground support equipment outlined above, the following instrumentation was used during the test:

1. Pressure transducer each for descent and ascent tank (range: 0 to 75 psia)

2. Descent and ascent tank disconnect pressure transducer (range: 0 to 75 psia)

3. Hoke valve differential pressure transducer (range: 0 to 50 psia)

4. Water flowmeter (range: 0- to 100-percent flow)

5. Hose discharge pressure transducer (range: 0 to 50 psia)

## Test Procedures

All tests were conducted in accordance with the development test plan for LM WMS for fire extinguishing purposes, Structures Branch Report no. 68-ES4-2. Test procedures have been excerpted from the test plan and are presented in Appendix C.

Six tests were conducted on the LM WMS simulator; three tests used the descent tank and three the ascent tank. The tests were labeled from A to F, inclusive, and had configurations as shown in table I.

Before each test, reference points were calibrated in accordance with the development test plan for LM WMS, Structures Branch Report no. 68-ES4-2 (Appendix C). During tests A, B, and C the Hoke valve was used to confine the flow to the limits established in the test plan. It was the intent of these tests to utilize the Hoke valve as a device to throttle the flow through the system to compensate for the actual pressure head loss to be encountered during actual flight conditions. For tests D, E, and F the Hoke valve was removed. The explanation for this action is found within the description of each individual test.

TABLE I.- TEST CONFIGURATIONS

| Test | Water tank | Water dispenser/ fire extinguisher | Hoke valve |
|---|---|---|---|
| A | D/S | NO | YES |
| B | A/S | NO | YES |
| C | D/S | YES | YES |
| D | A/S | YES | NO |
| E | D/S | YES | NO |
| F | A/S | YES | NO |

The test plan called for only one test run of each condition, but during the course of the testing it was decided to make one more test run for both descent and ascent water tank (tests E and F) to obtain a higher level of confidence in the flow characteristics.

The removal of the Hoke valve during tests D, E, and F and addition of tests E and F were the only deviations from the test plan.

## Data Requirements

Data were recorded during all the tests and are tabulated in appendix A. Time intervals between successive readings were recorded as well as total time elapsed from the beginning to end of tests. Figures 4 to 27 include flow characteristics curves plotted from this test data. The following data were plotted for all tests performed:

1. Flow rate versus pressure in the descent tank. ascent tank, disconnect discharge, and hose discharge

2. Flow rate versus differential pressure from tanks to hose discharge

3. Flow rate versus time

Additional graphs were plotted for tests C, D, E, and F and are as follows:

1. Water used and water remaining in the tanks versus time (See appendix B for the manner in which data were calculated to plot these graphs.)

2. Tank pressure versus time

## TEST DISCUSSIONS AND RESULTS

The results of all tests are described in this section and are also presented in summary form in table II.

### Test A and B - General

Test A configuration was D/S water tank without water dispenser/fire extinguisher, with Hoke valve. Test B configuration was A/S water tank without water dispenser/fire extinguisher, with Hoke valve. The first two tests, tests A and B, were functional in that the primary objective was to check out the system and to familiarize the personnel with the functional characteristics of the simulator. Data were obtained during the first two tests and are presented in appendix A. The initial pressure used during test A was 48.5 psia, and during test B was 49.0 psia. These pressures closely approach the pressure in the tanks of 48.0 psia during the prelaunch phase, but no correction was made to compensate for the pressure differential which would exist in the cabin during spaceflight. Tests A and B did not include the water dispenser/fire extinguisher as part of their configuration; therefore, no back pressure or pressure loss was experienced at the outlet.

After calibration of reference points the tests were conducted as outlined in step 4 of the test procedures (appendix C). That is, flows were consecutively established from 0.5 lb/min (equivalent to 5-percent flow) to a maximum obtainable flow of 8.6 lb/min (equivalent to 92-percent flow). These relations are shown in table III – Water Flow Conversion Table. Decreasing flows were then established from the highest flow (8.6 lb/min obtained in the first run), down to the initial low flow (0.5 lb/min). The above steps were repeated four times, with a decay of the high-flow reading as the pressure decreased. Descent and ascent tank pressures, disconnect discharge pressure, and Hoke valve differential pressure were recorded throughout the five cycles.

Summary for tests A and B: The highest pressures recorded were 48.0 psia for the descent tank and 49.0 psia for the ascent tank; the lowest pressures recorded were 23.9 psia and 15.2 psia, respectively. At the latter pressures the flows were not considered to be adequate and tests A and B were terminated. Elapsed time from beginning of the test to the end was not recorded.

## Tests C and D - General

For tests C and D the WMS was used in conjunction with the water dispenser/fire extinguisher. The descent and ascent water tanks were pressurized to 58 psia, which is 10 psia higher than initial operating flight pressure. This additional pressure in the tanks was provided to simulate more closely the actual pressure differential between the WMS and the LM cabin during flight with full tanks (approx. 43 psia), when full-water system is approximately 48 psia and the LM cabin pressure during flight is 4.6 to 5.0 psia. Following is a list of the pressure conditions which justify an initial tank pressure of 58 psia:

| | |
|---|---|
| Operating pressure during flight (full tanks) | = approx. 48 psia |
| Cabin pressure during flight | = 4.6 to 5.0 psia |
| Differential pressure between tanks and cabin | = approx. 43 psia |
| Tank pressure necessary during test | = approx. 58 psia |
| Ambient pressure during test | = 14.7 psia |
| Differential pressure during test | = approx. 43 psia |

Test C.- Test C configuration was D/S water tank with water dispenser/fire extinguisher, with Hoke valve. The test was conducted with a pressure of 58 psia in the descent tank. The Hoke valve upstream of the flowmeter was used to simulate a pressure drop equivalent to the decrease in pressure in the LM system. The water dispenser in the actual vehicle is located approximately 9.15 feet above the descent tank, resulting in an equivalent pressure drop of 0.7 psia at 1/6g environment. During the test it was discovered that the pressure drop across the fully opened Hoke valve was 1.85 psia, which is higher than the drop calculated to comprise the pressure head loss. Consequently, the data obtained are conservative for the period of time in which the Hoke valve pressure drop was higher than the expected drop. Eventually, as pressure and volume of the water in the tank dropped, the Hoke valve effectively throttled to maintain a drop of 0.7 psia.

Summary for test C: The highest flow rate obtained during test C was 5.05 lb/min. It was noted that the pressure in the tank dropped approximately 30 psia during the first 40 minutes as compared to a drop of approximately 4 to 5 psia during the remaining 90 minutes of the test. At T + 1 hour 6 minutes, when the flow was down to about 1.4 lb/min and the pressure in the tank was 19 psia, the flow readings became erratic. At this time the cone of water was 2 to 3 inches in diameter at approximately 1 foot from the dispenser. (Water from the extinguisher sprayer forms a full cone of water.) The cone of water formed at the beginning of the test was approximately 4 to 5 feet in diameter at a distance of 6 feet from the dispenser.

Test D.- Test D configuration was A/S water tank with water dispenser/fire extinguisher, without Hoke valve. The test was conducted with 58-psia pressure in the ascent tank. The Hoke valve was removed from the system because the tank is located above the water dispenser during ascent from the lunar surface and thereby eliminates the need for compensation since the pressure head does not act against the system.

Summary for test D: The highest flow rate obtained during test D was 5.05 lb/min. During the first 2 minutes of the test, the tank pressure dropped rapidly from 58 psia to 29.8 psia. At T + 6 minutes the pressure in the tank was down to approximately 21.0 psia and the flow was 1.87 lb/min. At this time the cone (or spray) of water out of the dispenser was only 2 to 3 inches in diameter 1 foot away from the dispenser.

As in test C, at the beginning of the test the cone was approximately 4 to 5 feet in diameter at a distance of 6 feet from the dispenser.

## Test E and F - General

For tests E and F, the WMS was used in conjuntion with the water dispenser/fire extinguisher. As in tests C and D, a tank pressure of 58 psia was used. The Hoke valve was taken out of the system because it was demonstrated during test C that the pressure drop across this valve was higher than anticipated. During tests E and F the readings were timed with more accuracy than during the preceding tests. Results obtained during tests E and F are considered to be as accurate as is possible with practicable operating standards.

Test E.- Test E configuration was D/S water tank with water dispenser/fire extinguisher, without Hoke valve. Test E, as in the previous tests, was conducted with a 58-psia descent tank pressure.

During this test the time interval between each successive set of readings was recorded with more accuracy than in other tests. A mathematical check was made of the time element by comparing the sum of the times elapsed between readings against the total time consumed from the start to the conclusion of the test. A comparison of the duration of test E with that of test C showed a difference between the two runs of only a few seconds.

Summary for test E: The highest flow rate obtained during test E was 5.42 lb/min. At T + 40 minutes the flow was down to 2.5 lb/min and the tank pressure was down to 24.6 psia. During the remaining 44 minutes of the test the pressure dropped to approximately 20 psia. At T + 1 hour 13 minutes the flow became erratic and the pressure had dropped to approximately 19 psia. The test was concluded at approximately T + 1 hour 24 minutes.

As in previous tests, the water cone formed at the beginning of the test was approximately 4 to 5 feet in diameter at a 6-foot distance from the water dispenser. At the end of the test the cone formed was 2 to 3 inches in diameter 1 foot away from the dispenser.

Test F.- Test F configuration was A/S water tank with water dispenser/fire extinguisher, without Hoke valve. Test F was conducted with 58 psia ascent tank pressure. During this test the time lapse between each successive set of readings was recorded with more accuracy than in test D. Flow which was considered adequate lasted for approximately 10 minutes, which is 4 minutes longer than in test D. No reasonable explanation can be found for the apparent time anomaly concerning the duration of test D.

Summary for test F: The highest flow rate recorded during test F was 5.23 lb/min. At T + 10 minutes the flow was down to 1.9 lb/min and the tank pressure was down to 21.0 psia. At this time the cone of water out of the dispenser was approximately 2 to 3 inches in diameter at a 1-foot distance from the dispenser. As in all of the tests, a cone of water 4 to 5 feet in diameter was formed 6 feet away from the dispenser at the beginning of the test.

## CONCLUDING REMARKS

The results of the various tests presented in this document established the flow rates and pressures to the water dispenser/fire extinguisher during different stages of flight with tank pressures in the range of 58 to 21 psia (43.3 to 6.3 psig). Under actual LM flight conditions (5.0 psia cabin pressure) the water tanks are essentially empty

at about 7 psig. The test results (6.3 psig minimum) verify the capability of the WMS to provide flows at pressures below the minimum expected in flight. However, it should be noted that during the course of this series of tests, no allowance was made for additional uses for this water such as: water required for the crew, for the sublimators, and for portable life support system. Therefore, a thorough investigation of the water profile for each mission, in conjunction with the data presented in this document, would provide the information necessary for determining the amount of water available for fire suppression onboard the LM during lunar missions.

## RECOMMENDATIONS

Following are recommendations for further study of the LM water management system:

1. Followup tests should be conducted using actual fires within the spacecraft mockup to determine the fire extinguishing capabilities of the system. Special emphasis should be placed on the lower flows and pressures so as to determine minimum capabilities of the system.

2. The LM water management system simulator and associated equipment should be used in conjunction with the LM Mockup or equivalent.

TABLE II.- SUMMARY OF TEST RESULTS

| Test | Tank and pressure | Hoke valve | Minimum acceptable tank pressure[a], psia | ΔP, tank to hose discharge | Water dispenser | Maximum flow, lb/min | Minimum recorded flow, lb/min | Time[b], min |
|---|---|---|---|---|---|---|---|---|
| A calibration | Descent 48 psia | Yes | N/A | N/A | No | 8.6 | 0.5 | N/A |
| B calibration | Ascent 48 psia | Yes | N/A | N/A | No | 6.6 | 0.5 | N/A |
| C | Descent 58 psia | Yes | 19 | See fig. 9 | Yes | 5.05 | 1.40 | 66 |
| D | Ascent 58 psia | No | 21 | See fig. 14 | Yes | 5.05 | 1.87 | 6 |
| E | Descent 58 psia | No | 19 | See fig. 19 | Yes | 5.42 | 1.50 | 73 |
| F | Ascent 58 psia | No | 21 | See fig. 24 | Yes | 5.23 | 1.9 | 10 |

[a]This pressure sustains a water cone of 2 to 3 inches in diameter, 1 foot away (original pressure of 58 psia formed 4- to 5-foot diameter cone 6 feet away).

[b]Time elapsed from the beginning of the test until such time as the flow was not considered adequate.

TABLE III.- WATER FLOW CONVERSION

PERCENT TO POUNDS/MINUTE

| Percent | lb/min | Percent | lb/min | Percent | lb/min |
|---|---|---|---|---|---|
| 1 | 0.09 | 34 | 3.18 | 68 | 6.35 |
| 2 | .19 | 35 | 3.27 | 69 | 6.45 |
| 3 | .28 | 36 | 3.36 | 70 | 6.54 |
| 4 | .37 | 37 | 3.46 | 71 | 6.63 |
| 5 | .47 | 38 | 3.55 | 72 | 6.73 |
| 6 | .56 | 39 | 3.64 | 73 | 6.82 |
| 7 | .65 | 40 | 3.74 | 74 | 6.91 |
| 8 | .75 | 41 | 3.83 | 75 | 7.01 |
| 9 | .84 | 42 | 3.92 | 76 | 7.10 |
| 10 | .93 | 43 | 4.02 | 77 | 7.19 |
| 11 | 1.03 | 44 | 4.11 | 78 | 7.29 |
| 12 | 1.12 | 45 | 4.20 | 79 | 7.38 |
| 13 | 1.21 | 46 | 4.30 | 80 | 7.47 |
| 14 | 1.31 | 47 | 4.39 | 81 | 7.57 |
| 15 | 1.40 | 48 | 4.48 | 82 | 7.66 |
| 16 | 1.49 | 49 | 4.58 | 83 | 7.75 |
| 17 | 1.59 | 50 | 4.67 | 84 | 7.85 |
| 18 | 1.68 | 51 | 4.76 | 85 | 7.94 |
| 19 | 1.78 | 52 | 4.86 | 86 | 8.03 |
| 20 | 1.87 | 53 | 4.95 | 87 | 8.13 |
| 21 | 1.96 | 54 | 5.05 | 88 | 8.22 |
| 22 | 2.06 | 55 | 5.14 | 89 | 8.31 |
| 23 | 2.15 | 56 | 5.23 | 90 | 8.41 |
| 24 | 2.24 | 57 | 5.33 | 91 | 8.50 |
| 25 | 2.34 | 58 | 5.42 | 92 | 8.60 |
| 26 | 2.43 | 59 | 5.51 | 93 | 8.69 |
| 27 | 2.52 | 60 | 5.61 | 94 | 8.78 |
| 28 | 2.62 | 61 | 5.70 | 95 | 8.88 |
| 29 | 2.71 | 62 | 5.79 | 96 | 8.97 |
| 30 | 2.80 | 63 | 5.89 | 97 | 9.06 |
| 31 | 2.90 | 64 | 5.98 | 98 | 9.16 |
| 32 | 2.99 | 65 | 6.07 | 99 | 9.25 |
| 33 | 3.08 | 66 | 6.17 | 100 | 9.34 |
| | | 67 | 6.26 | | |

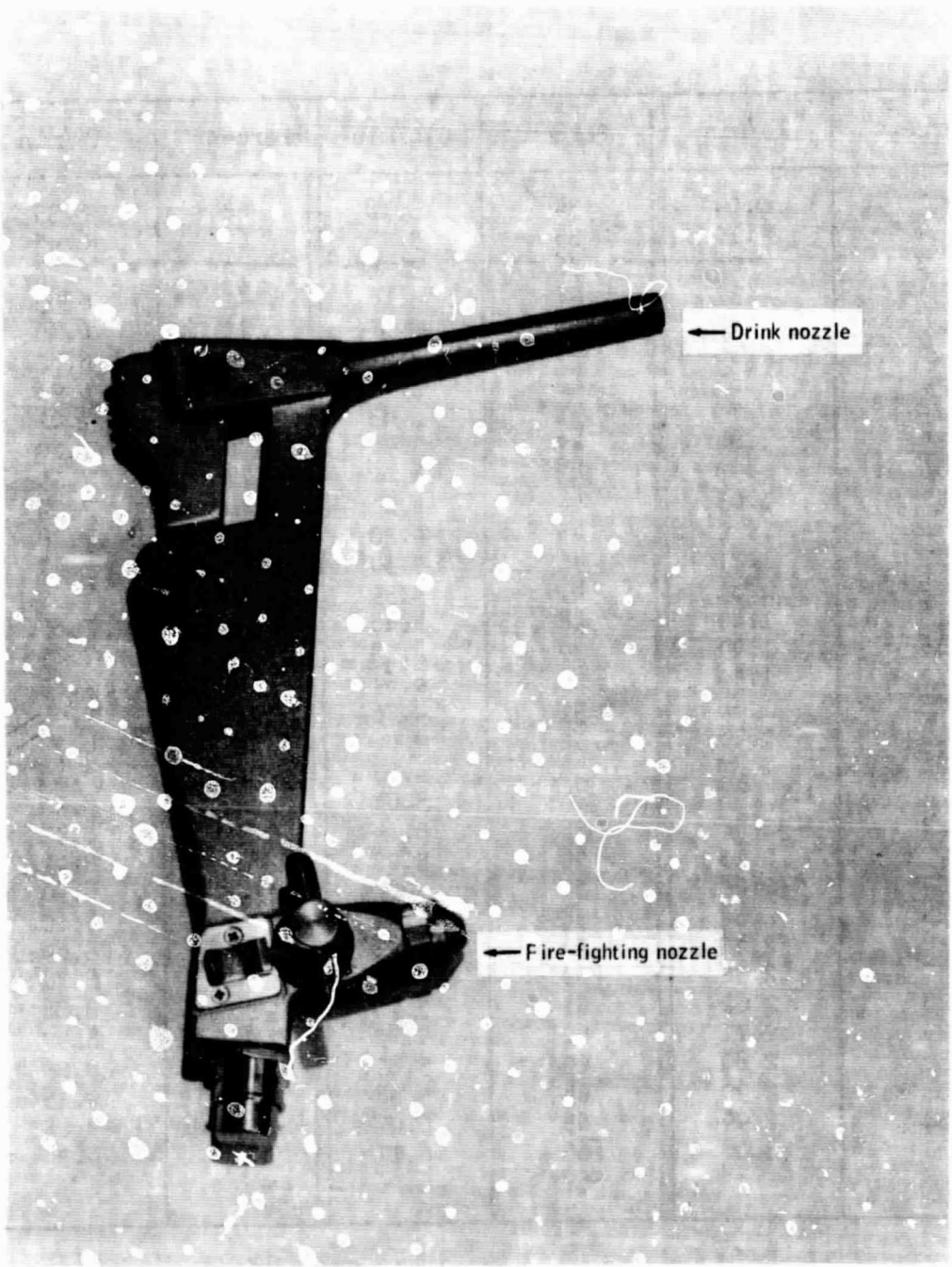



Figure 1. - Water dispenser/fire extinguisher designed for lunar module.

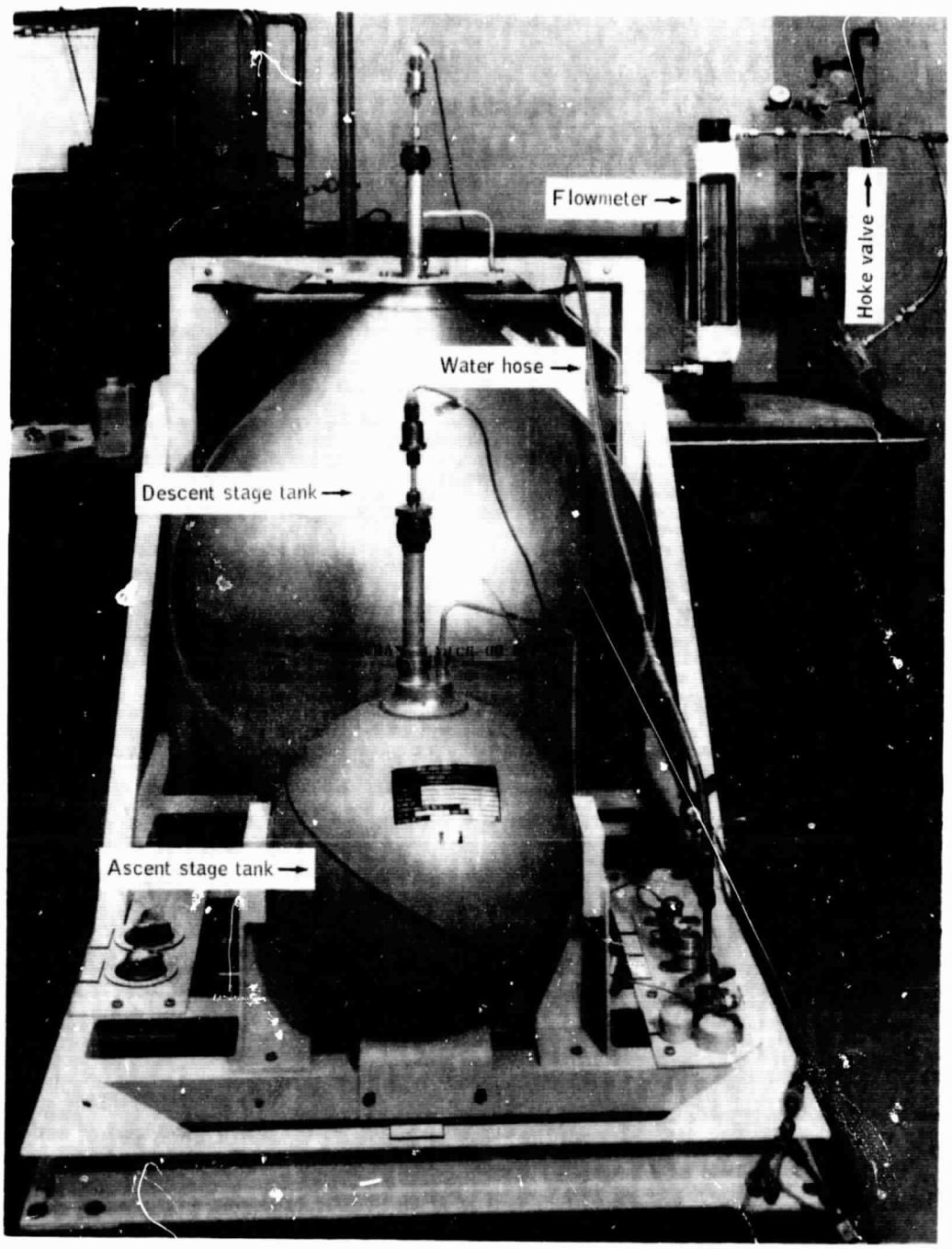



Figure 2.- The LM Water Management System simulator.

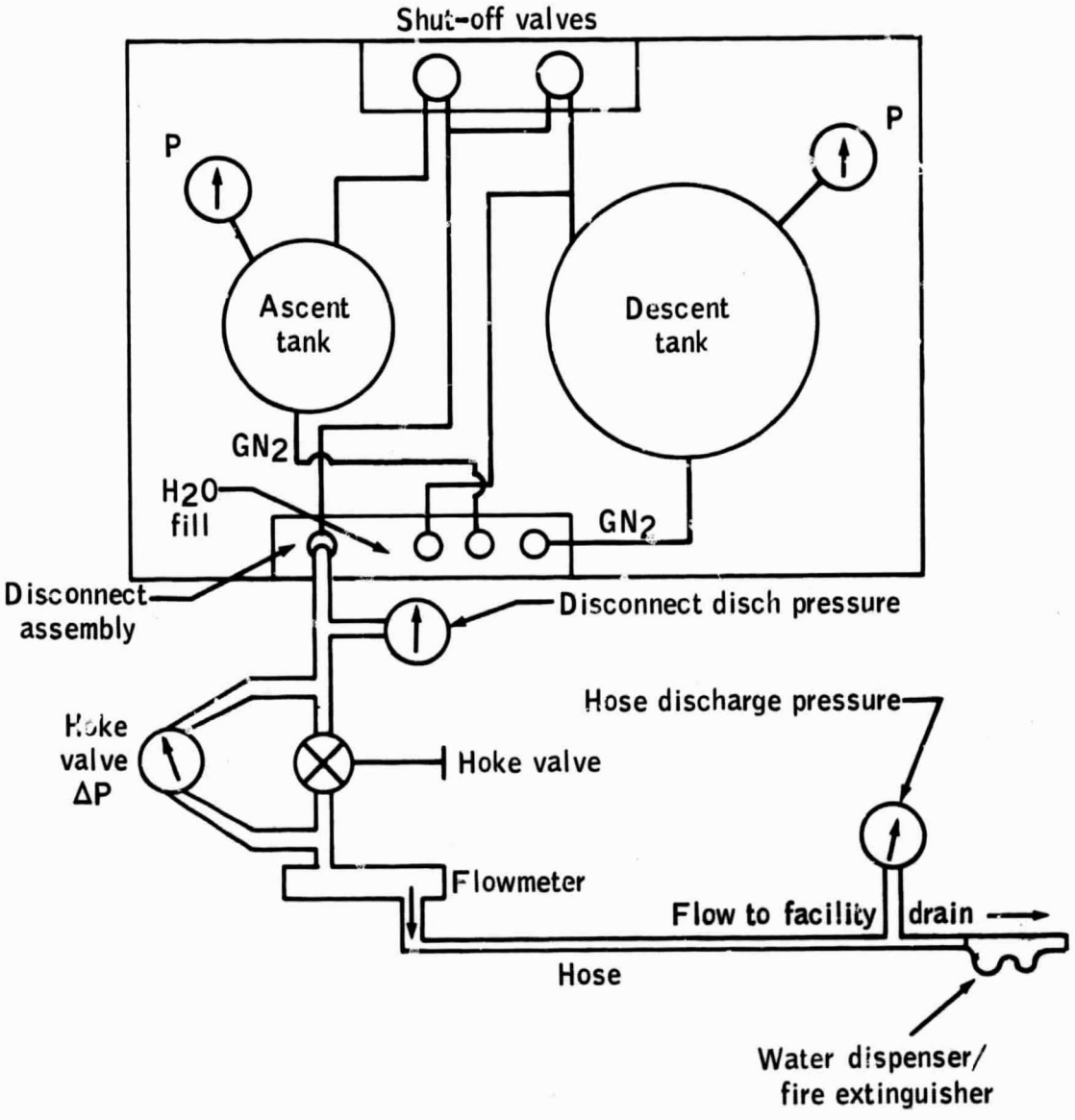



Figure 3.- Schematic of LM Water Management System simulator.

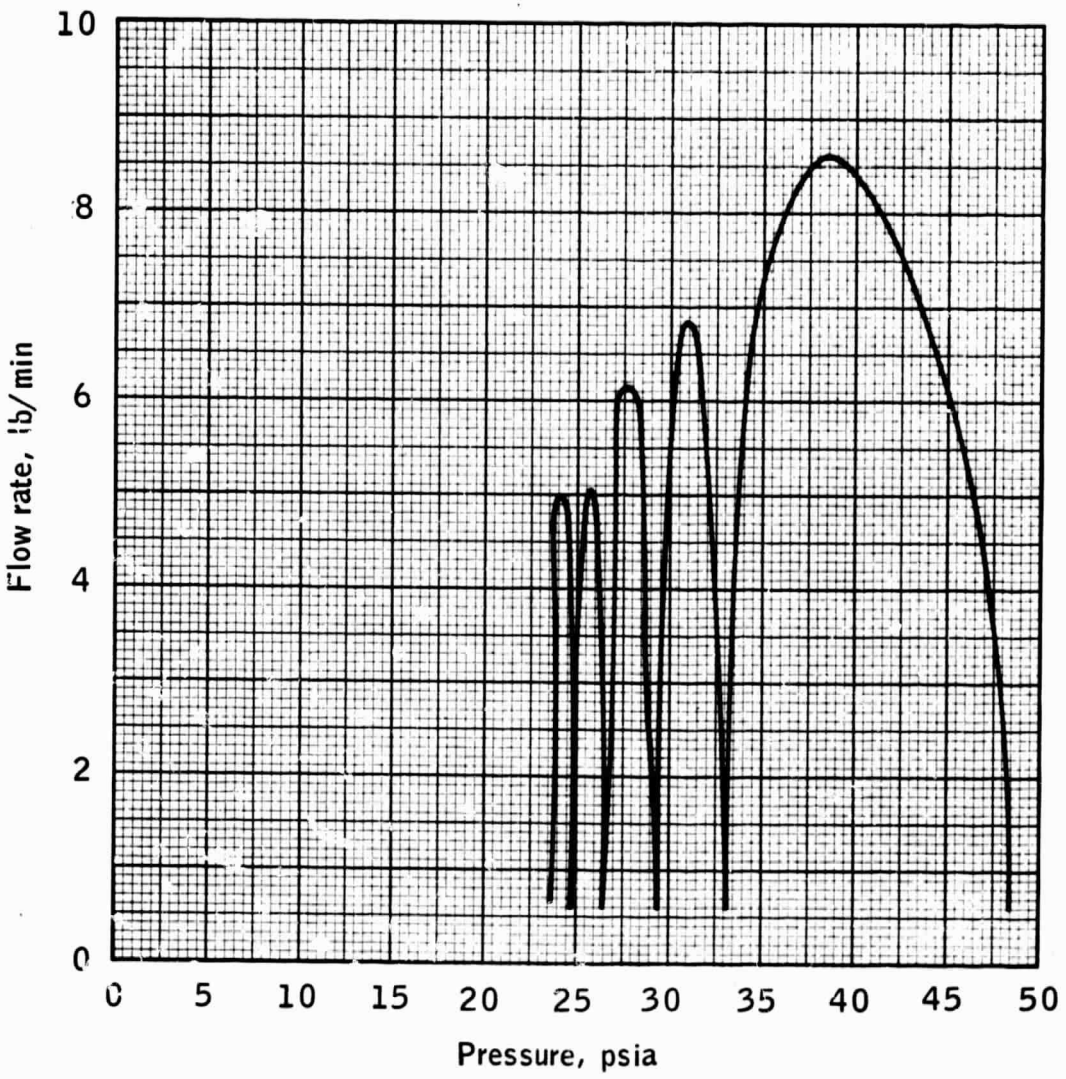



Figure 4.- Test A — flow rate versus descent tank pressure.

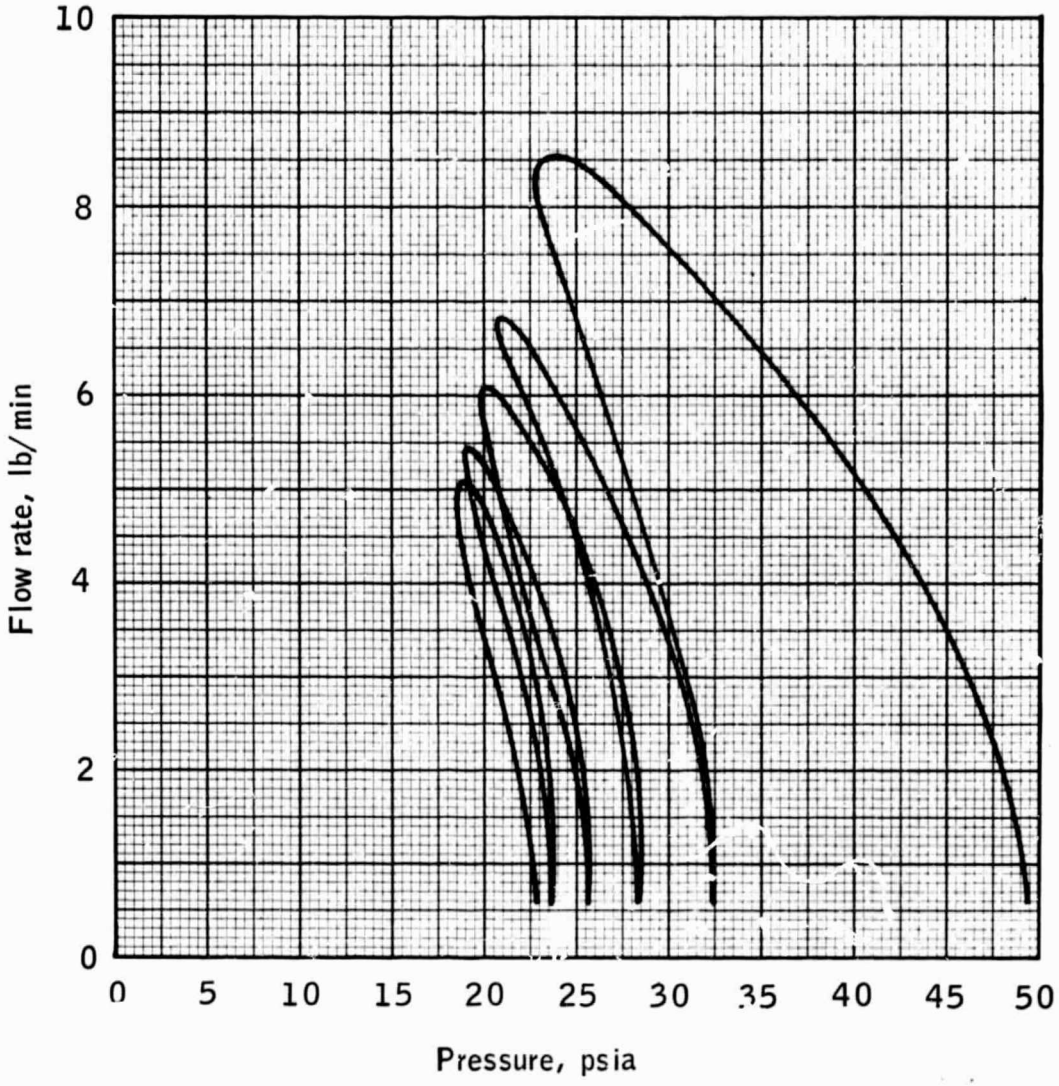



Figure 5.- Test A — flow rate versus disconnect discharge pressure.

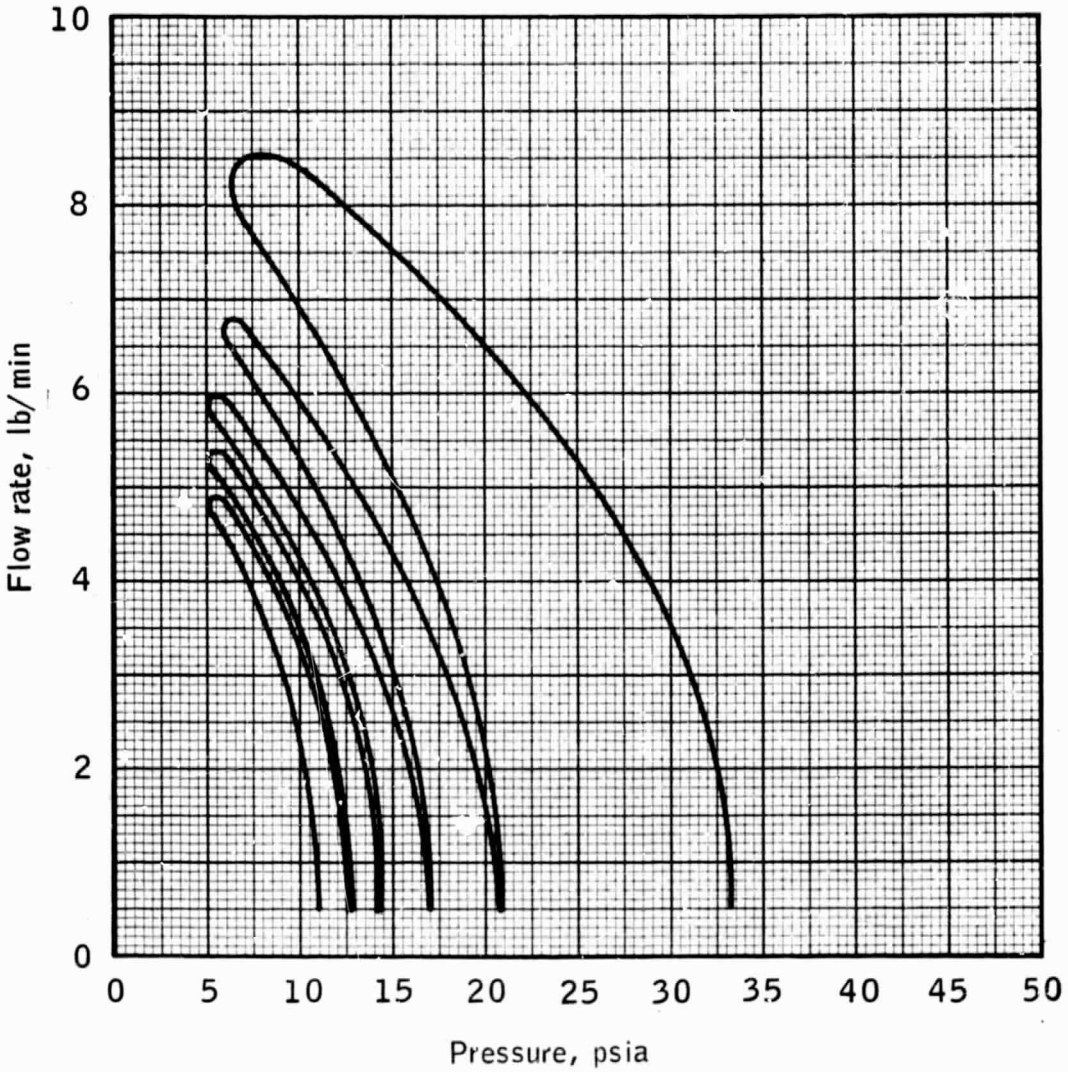



Figure 6.- Test A — flow rate versus Hoke valve pressure.

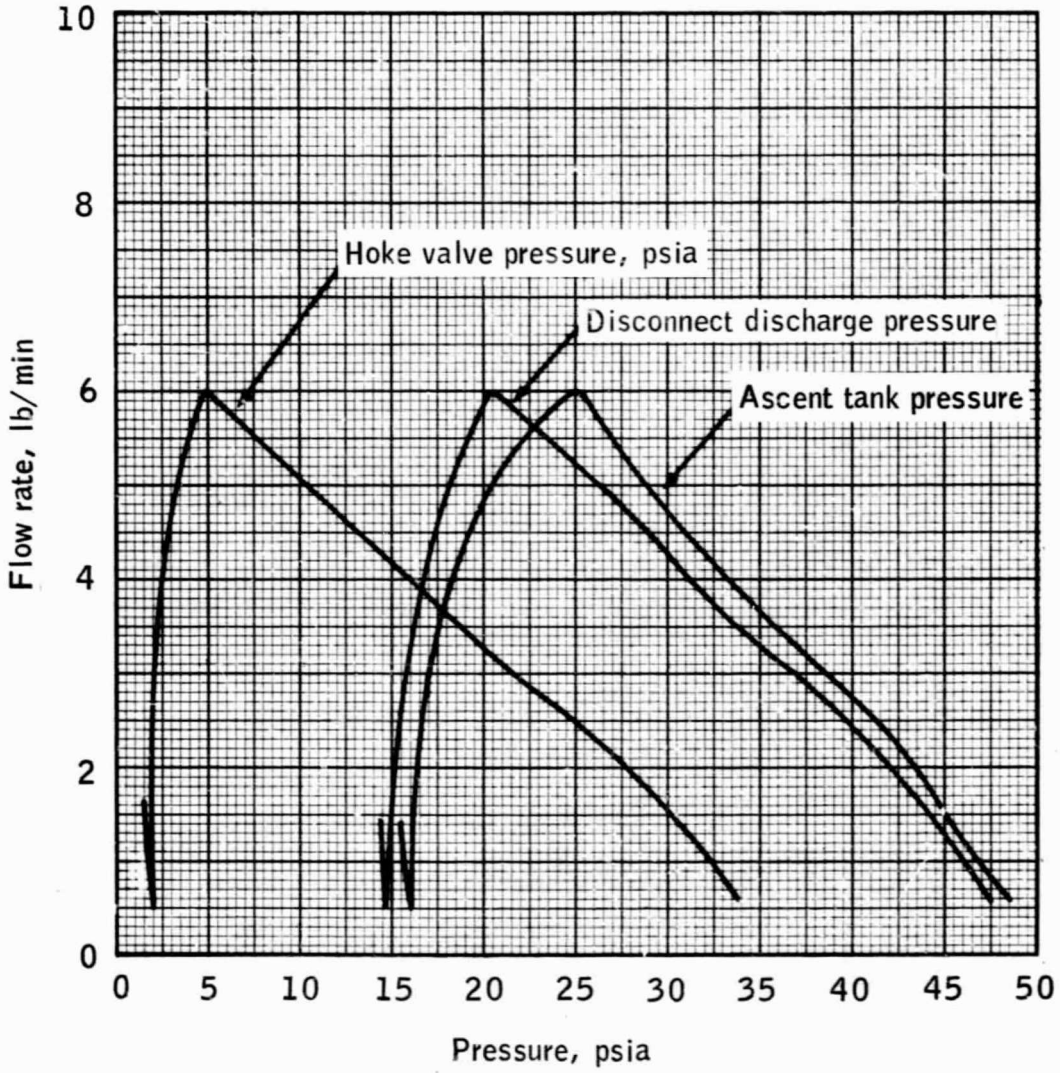



Figure 7.- Test B — flow rate versus ascent tank and line pressures.

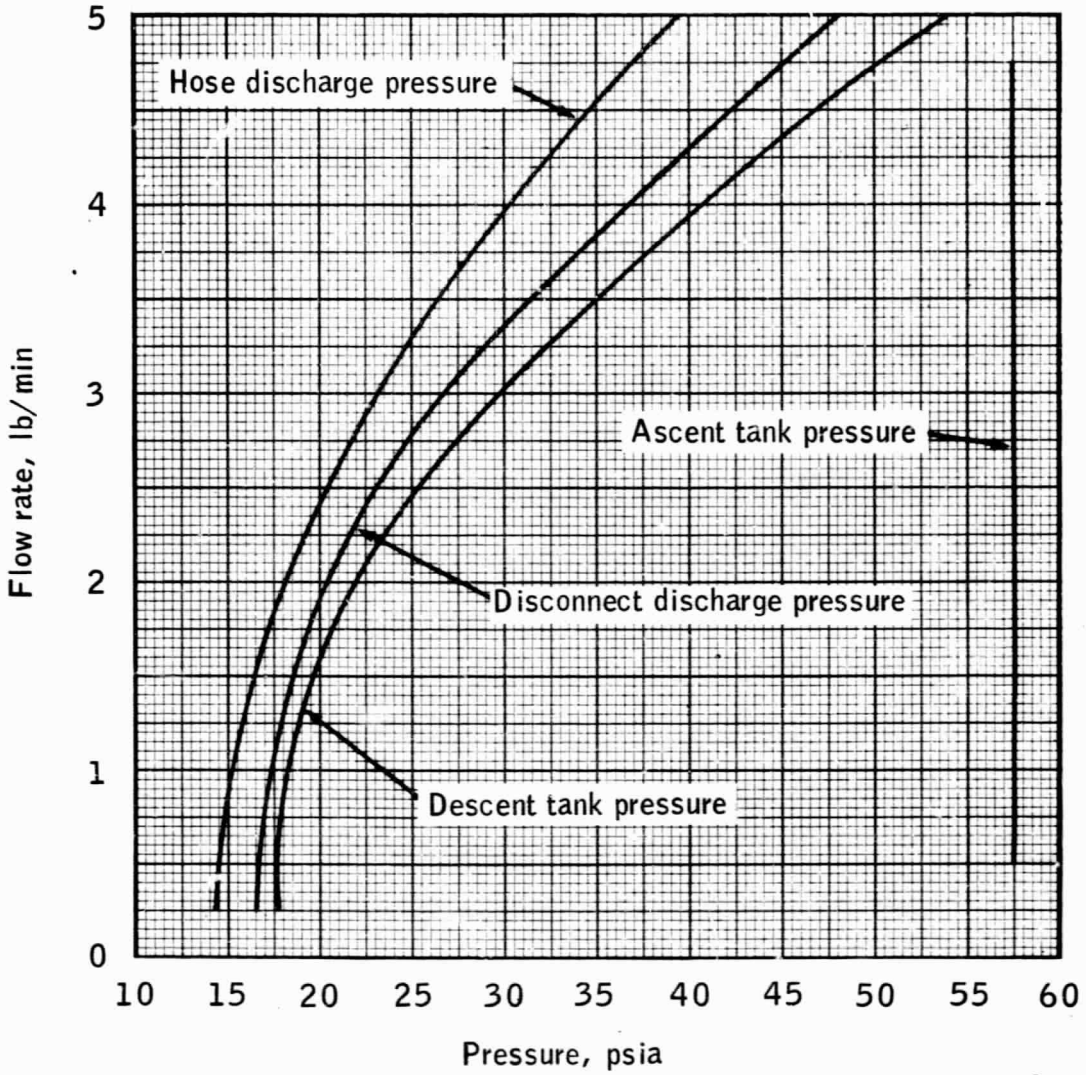



Figure 8.- Test C — flow rate versus descent tank and line pressures.

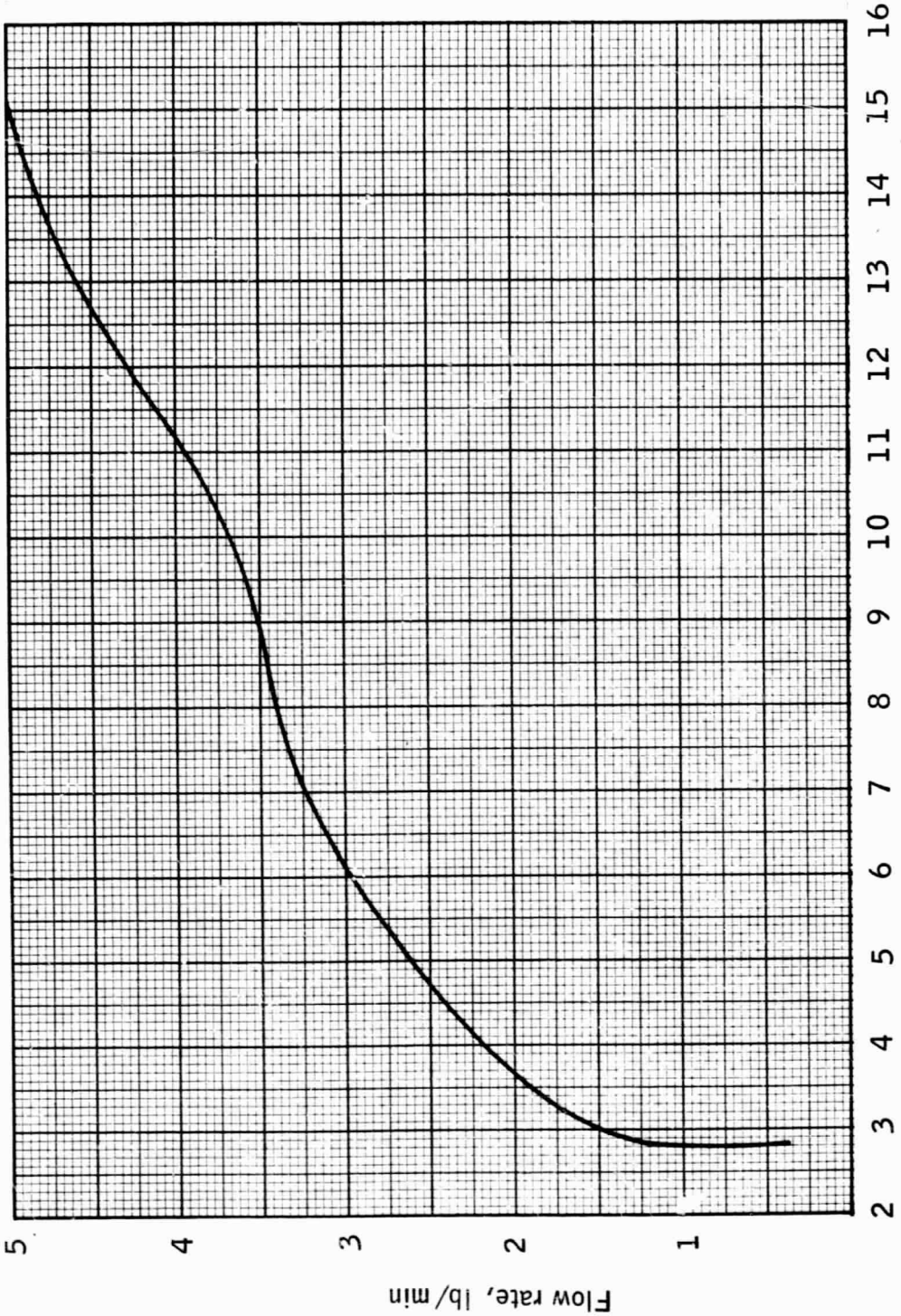



Figure 9.- Test C — flow rate versus descent tank-hose discharge differential pressure.

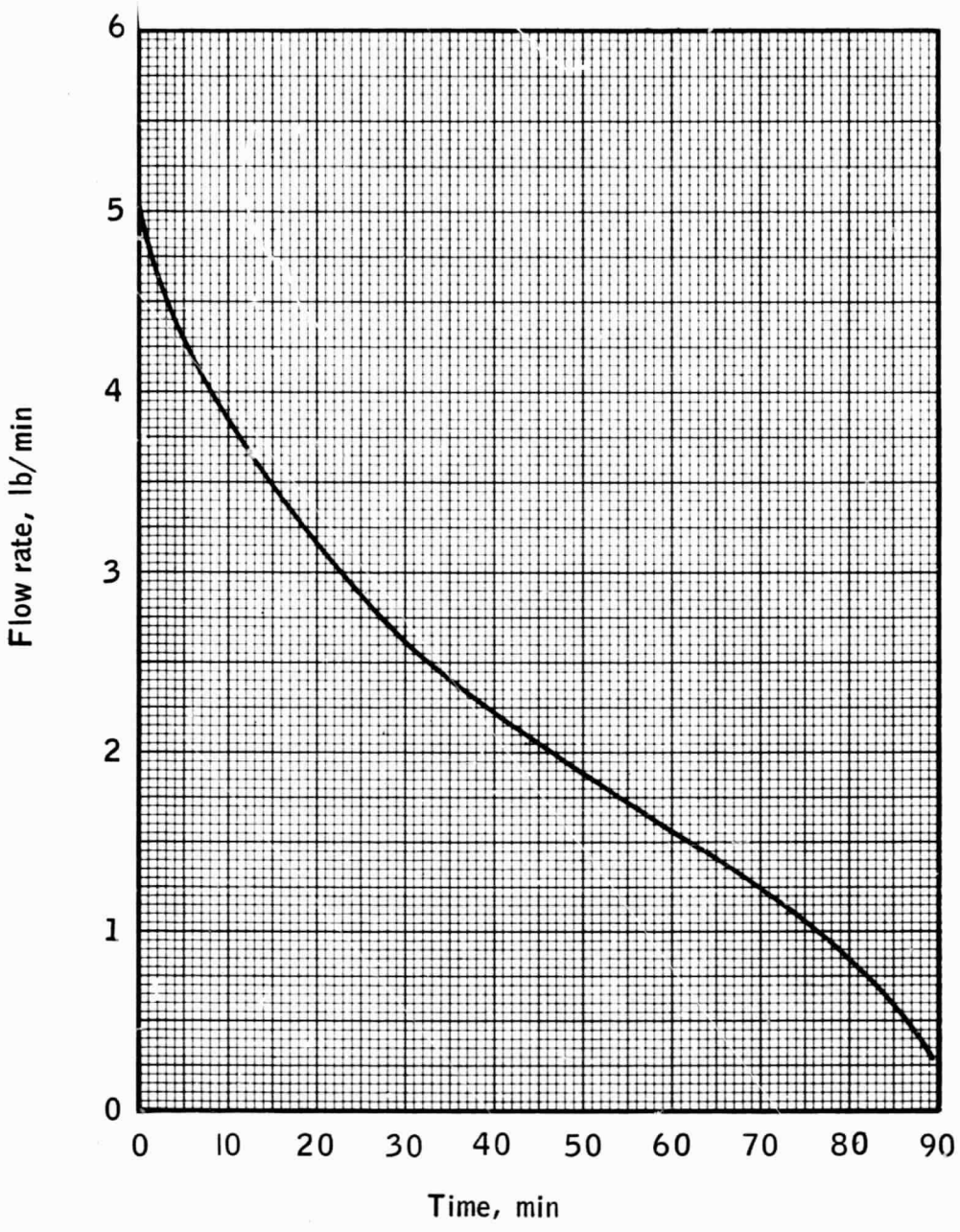



Figure 10.- Test C — line flow rate versus time.

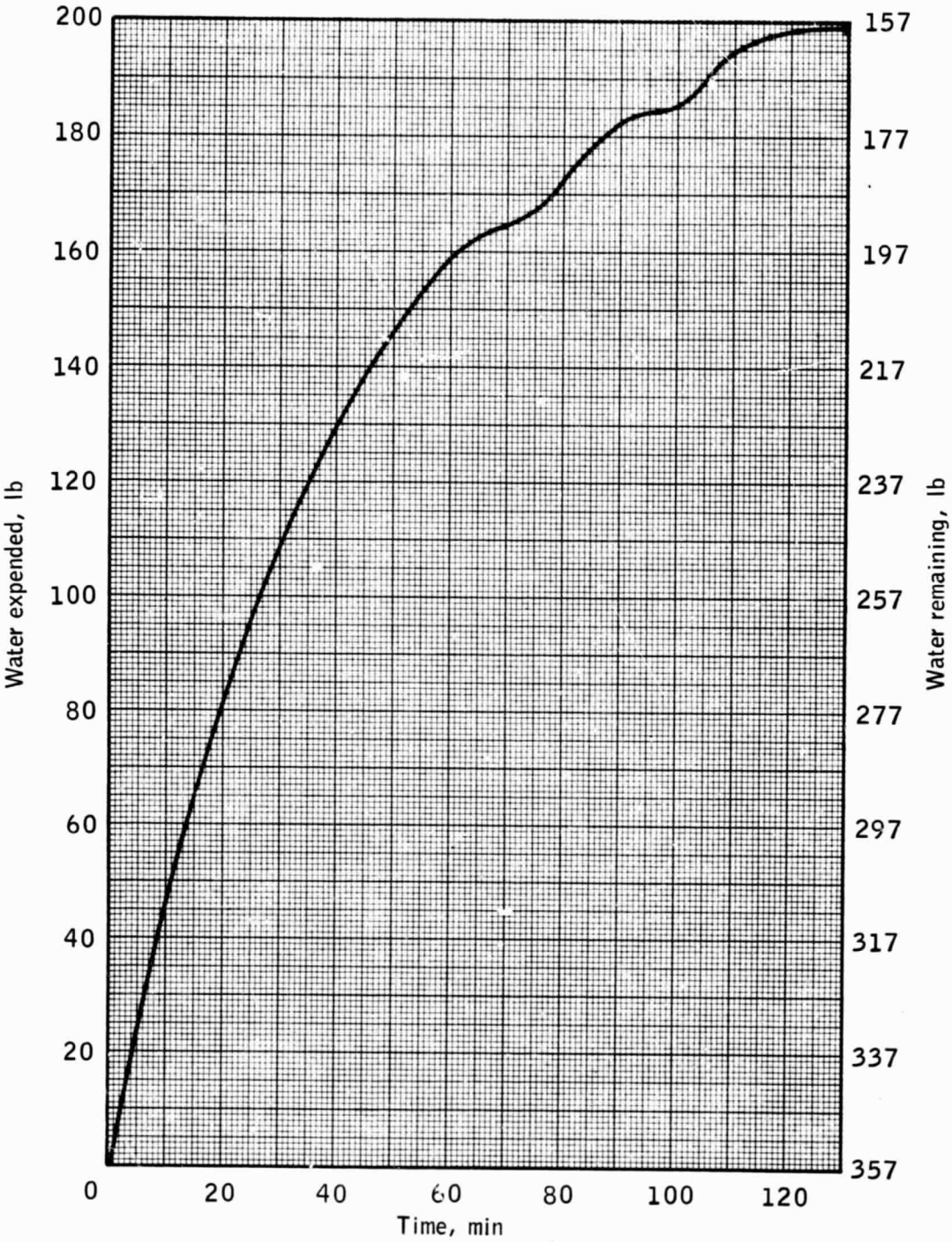



Figure 11.- Test C — descent tank water expended versus time.

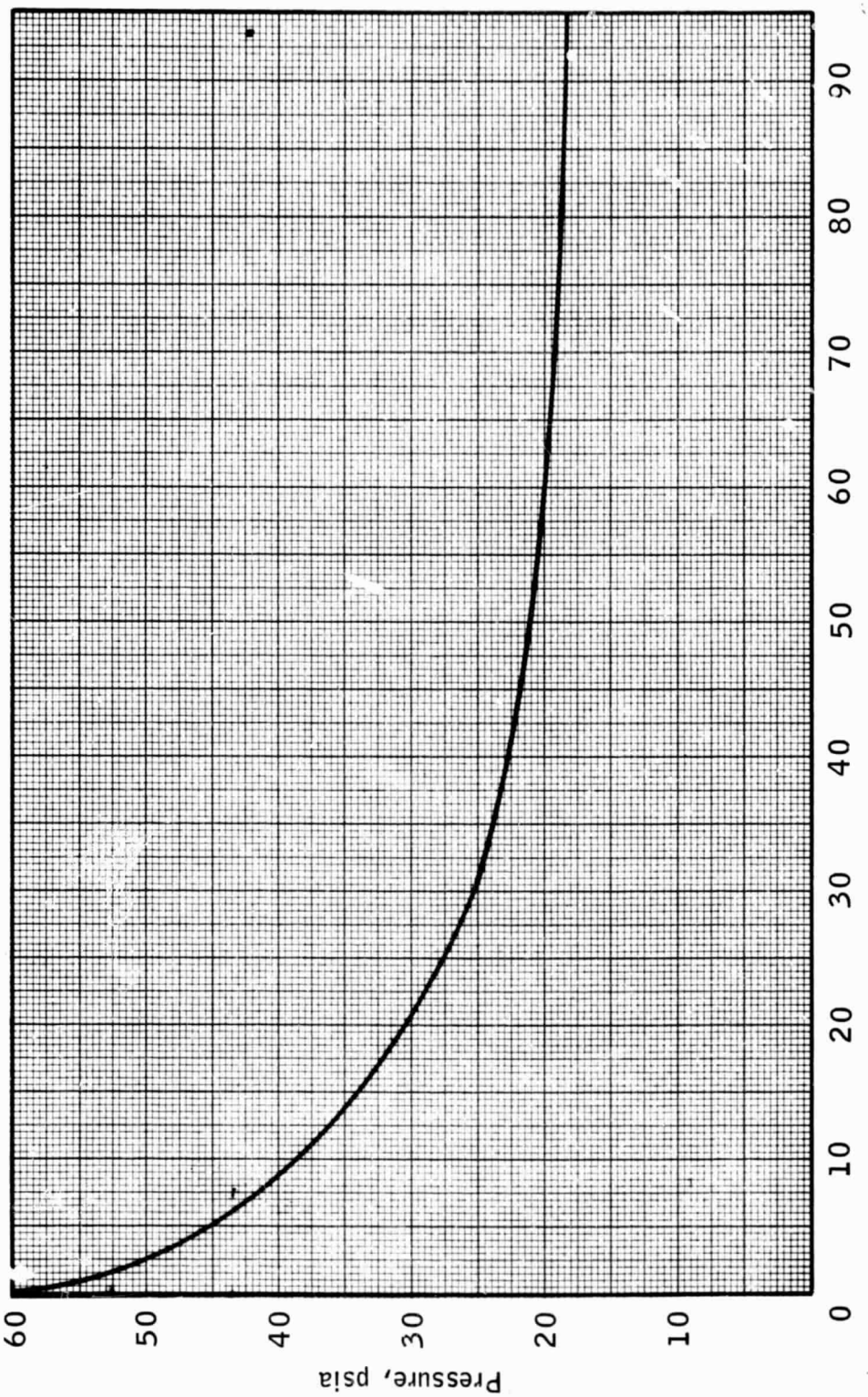



Figure 12.- Test C — descent tank pressure versus time.

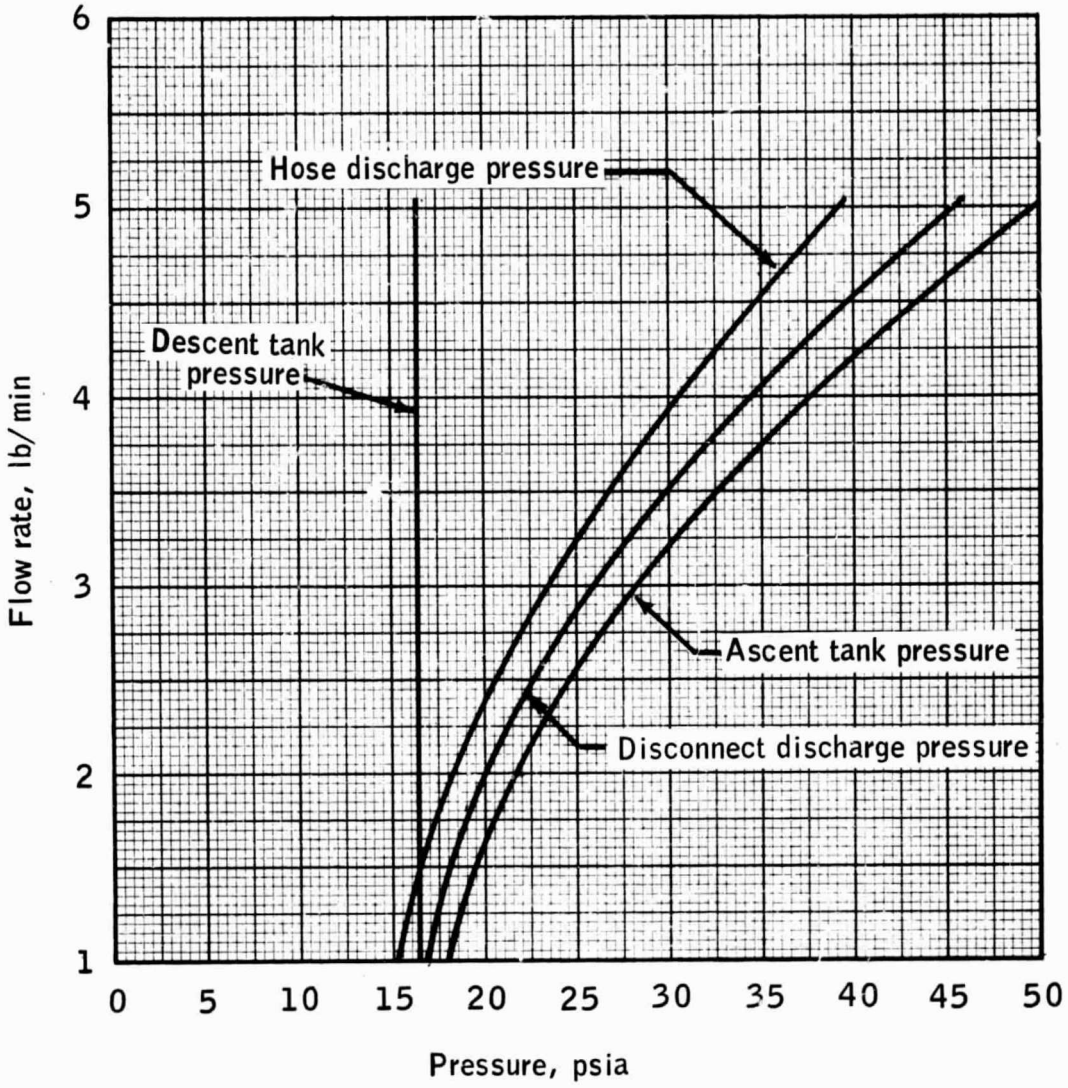



Figure 13.- Test D — flow rate versus ascent tank and line pressures.

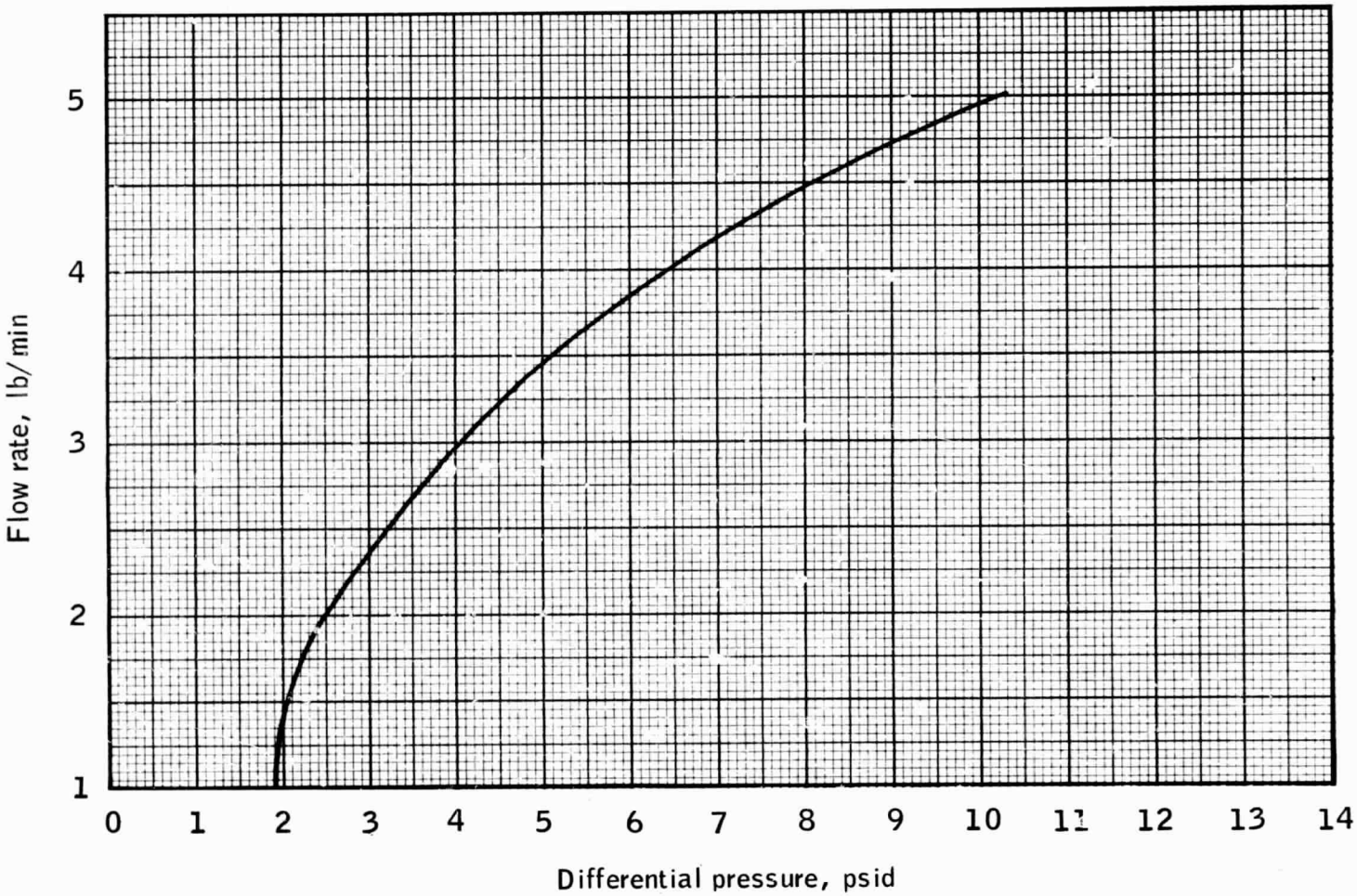



Figure 14.- Test D — flow rate versus ascent tank-hose discharge differential pressure.

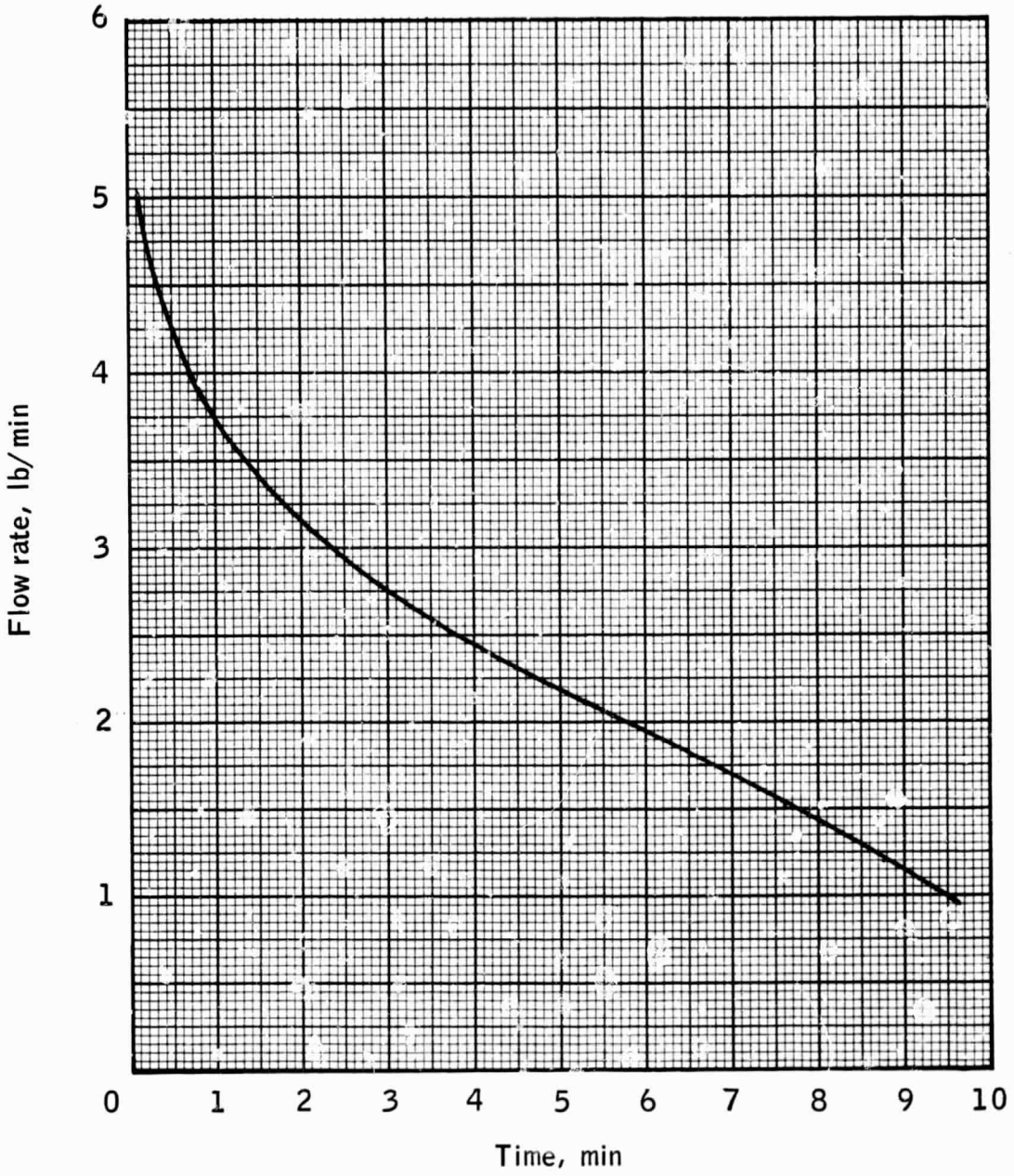



Figure 15.- Test D — line flow rate versus time.

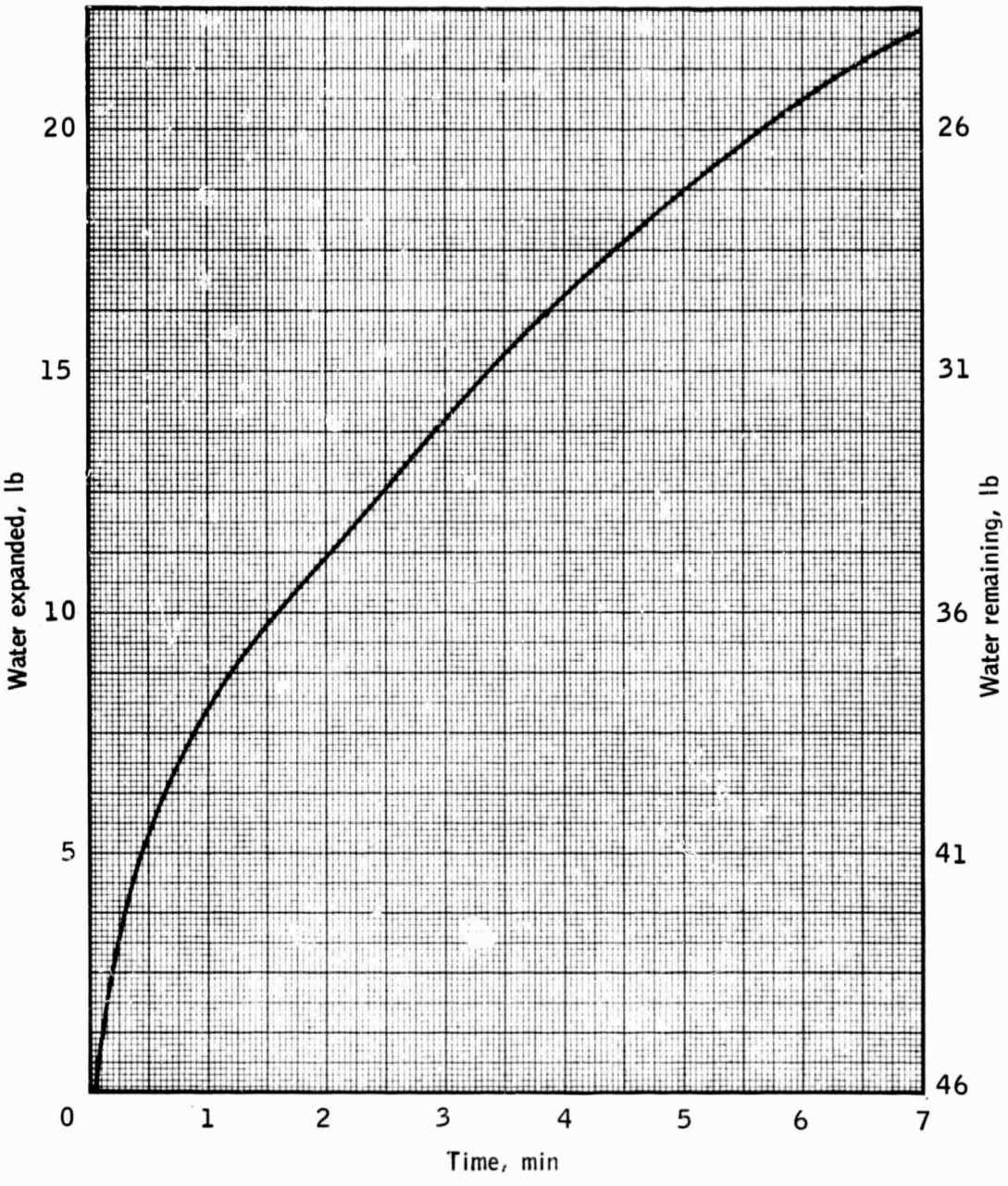



Figure 16.- Test D — ascent tank water expended versus time.

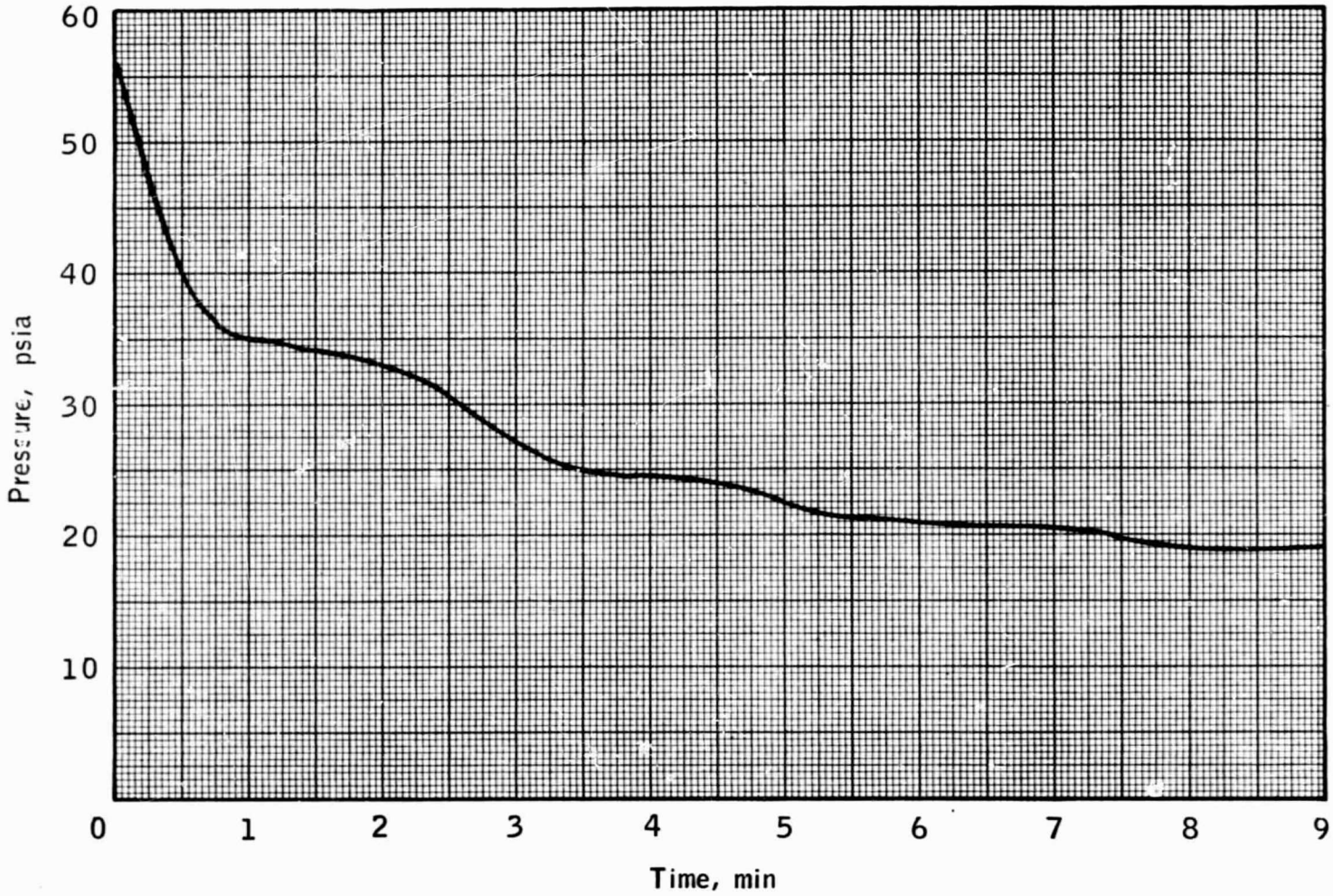



Figure 17.- Test D — ascent tank pressure versus time.

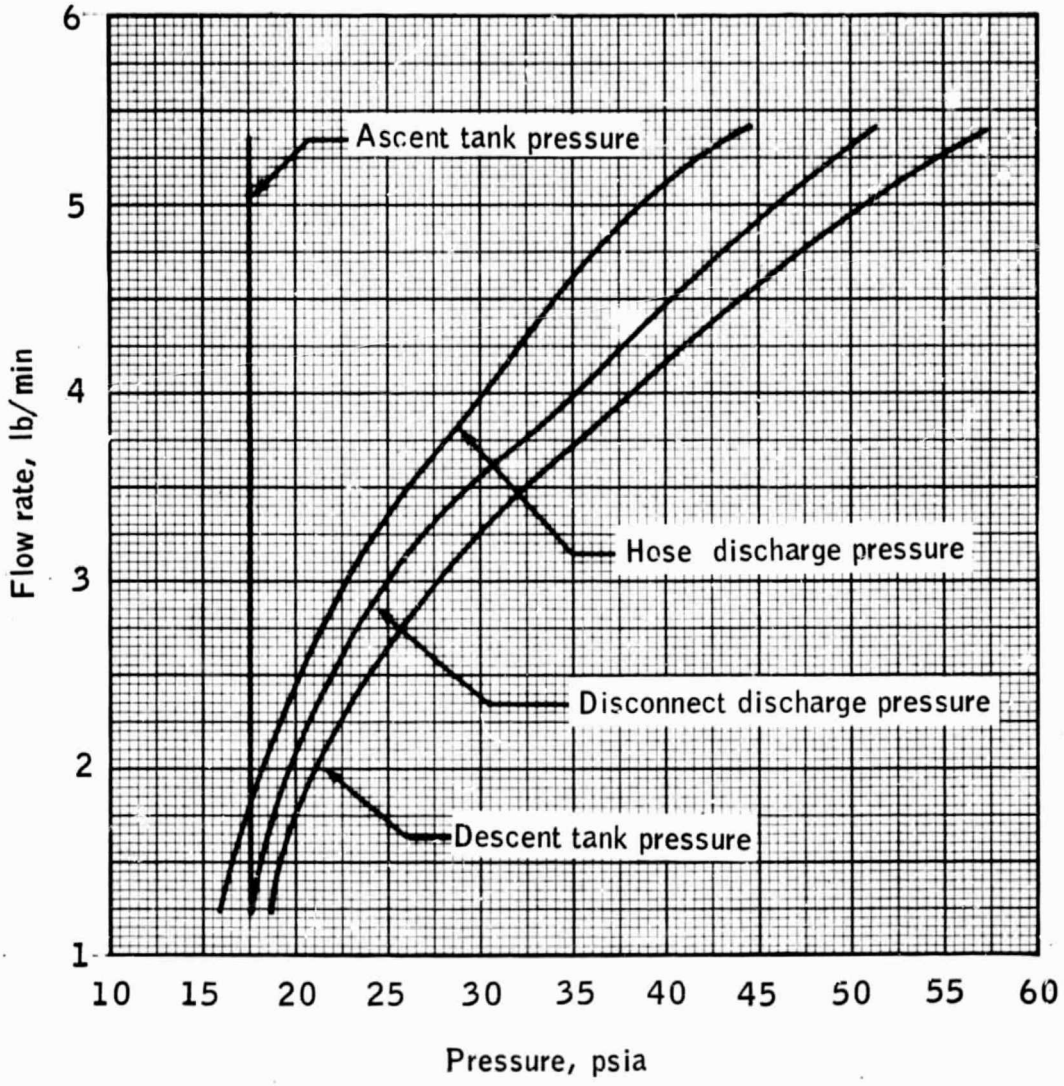



Figure 18.- Test E — flow rate versus descent tank and line pressures.

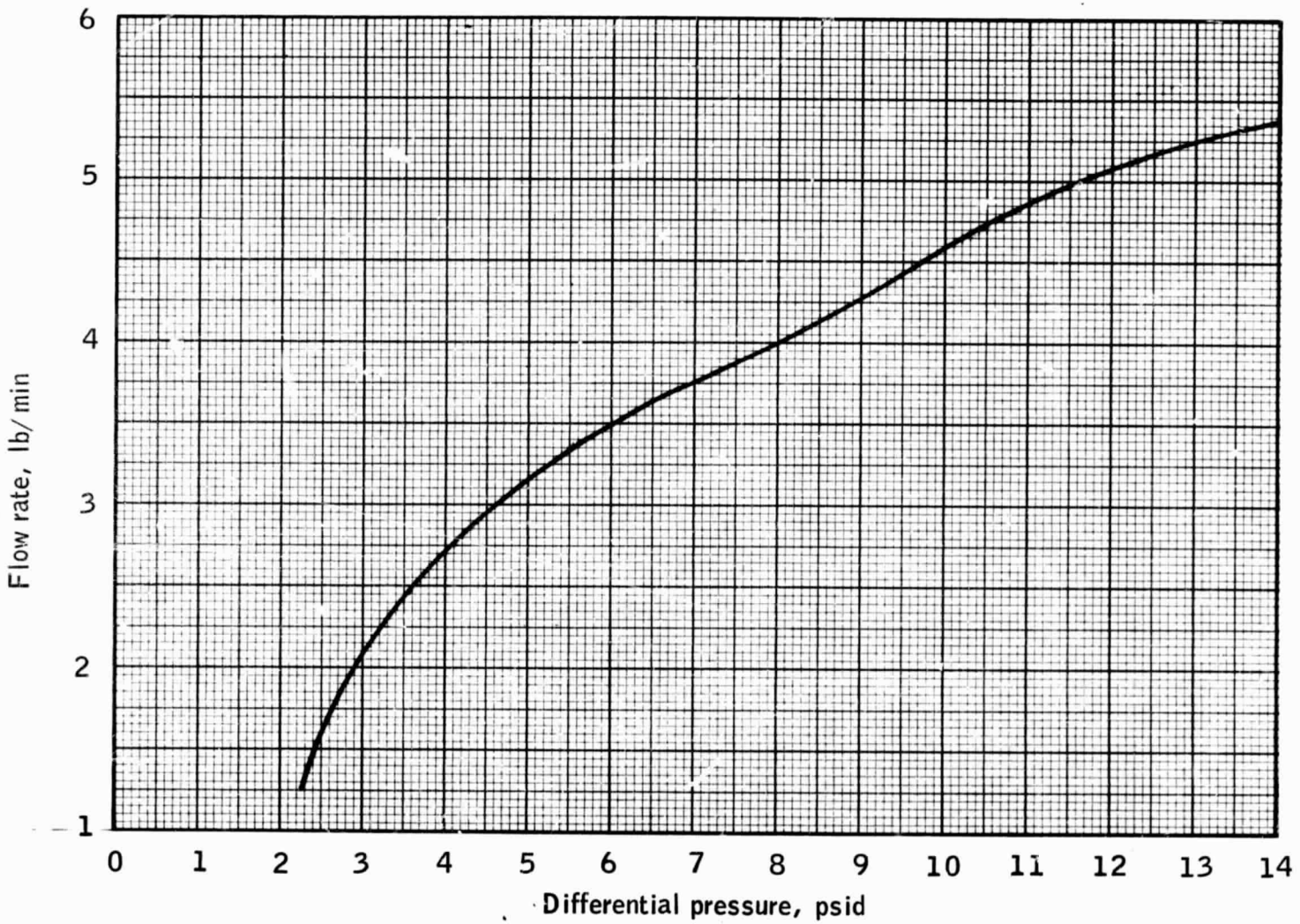



Figure 19.- Test E — flow rate versus descent tank-hose discharge differential pressure.

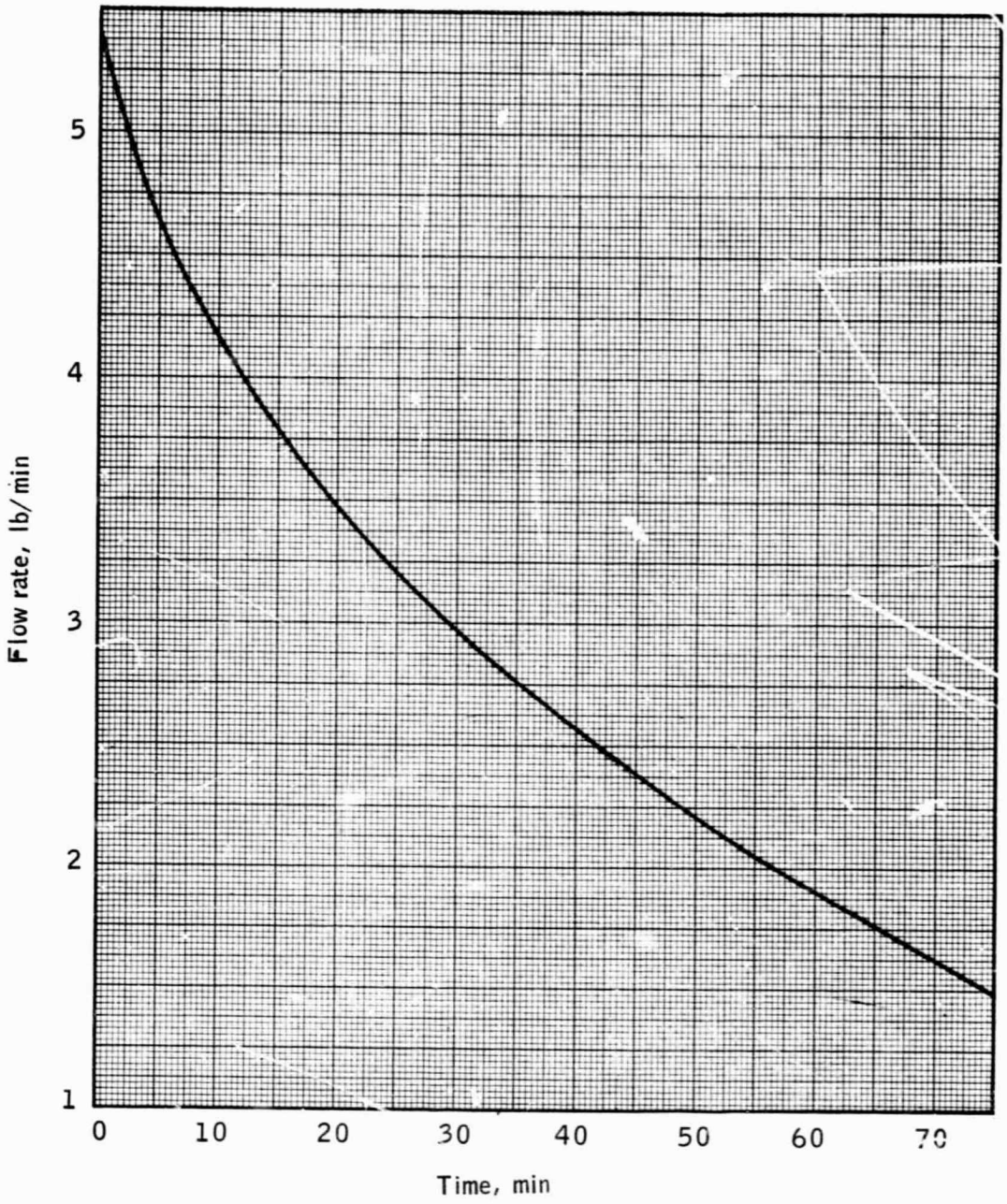



Figure 20.- Test E — line flow rate versus time.

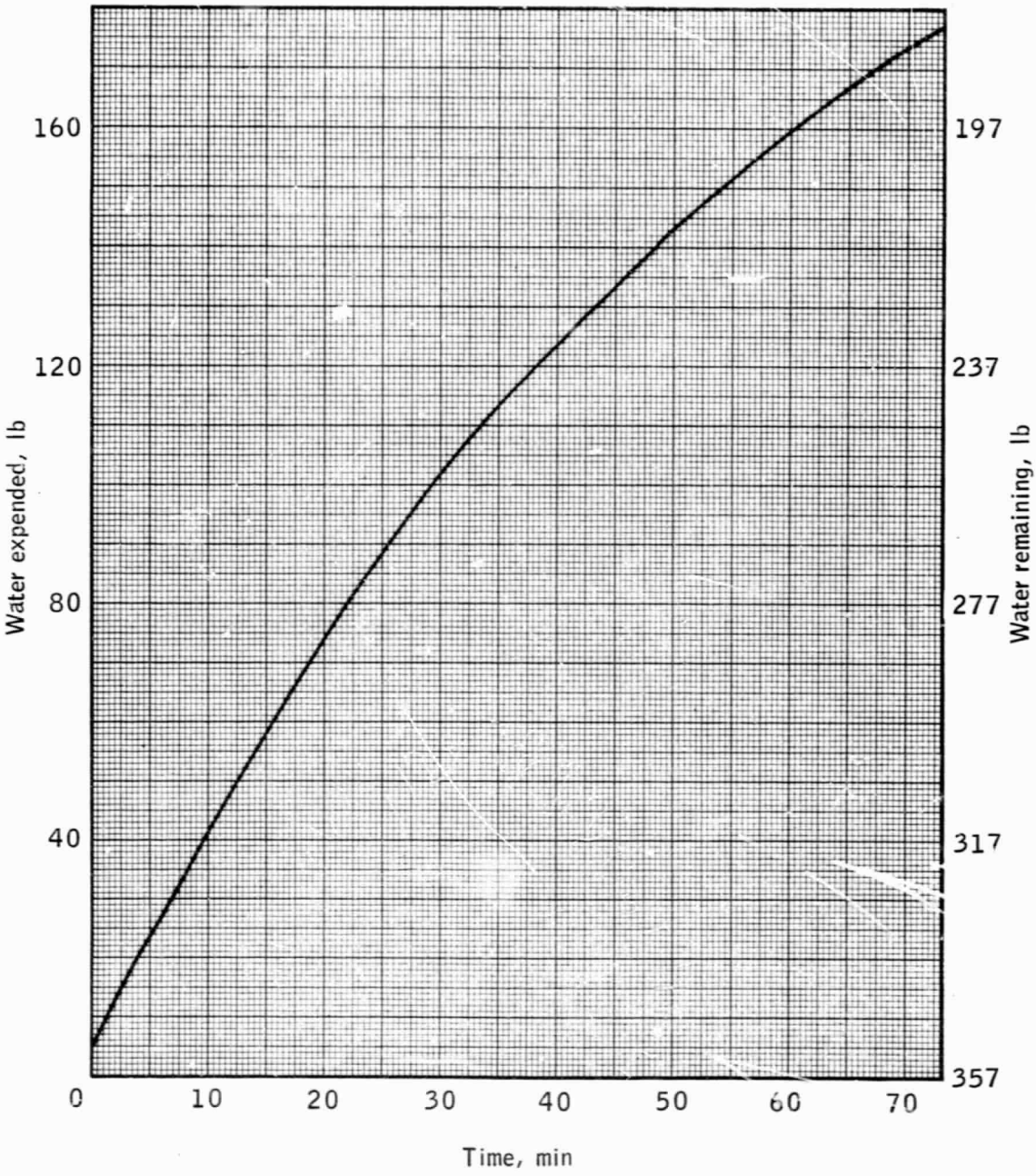



Figure 21.- Test E — descent tank water expended versus time.

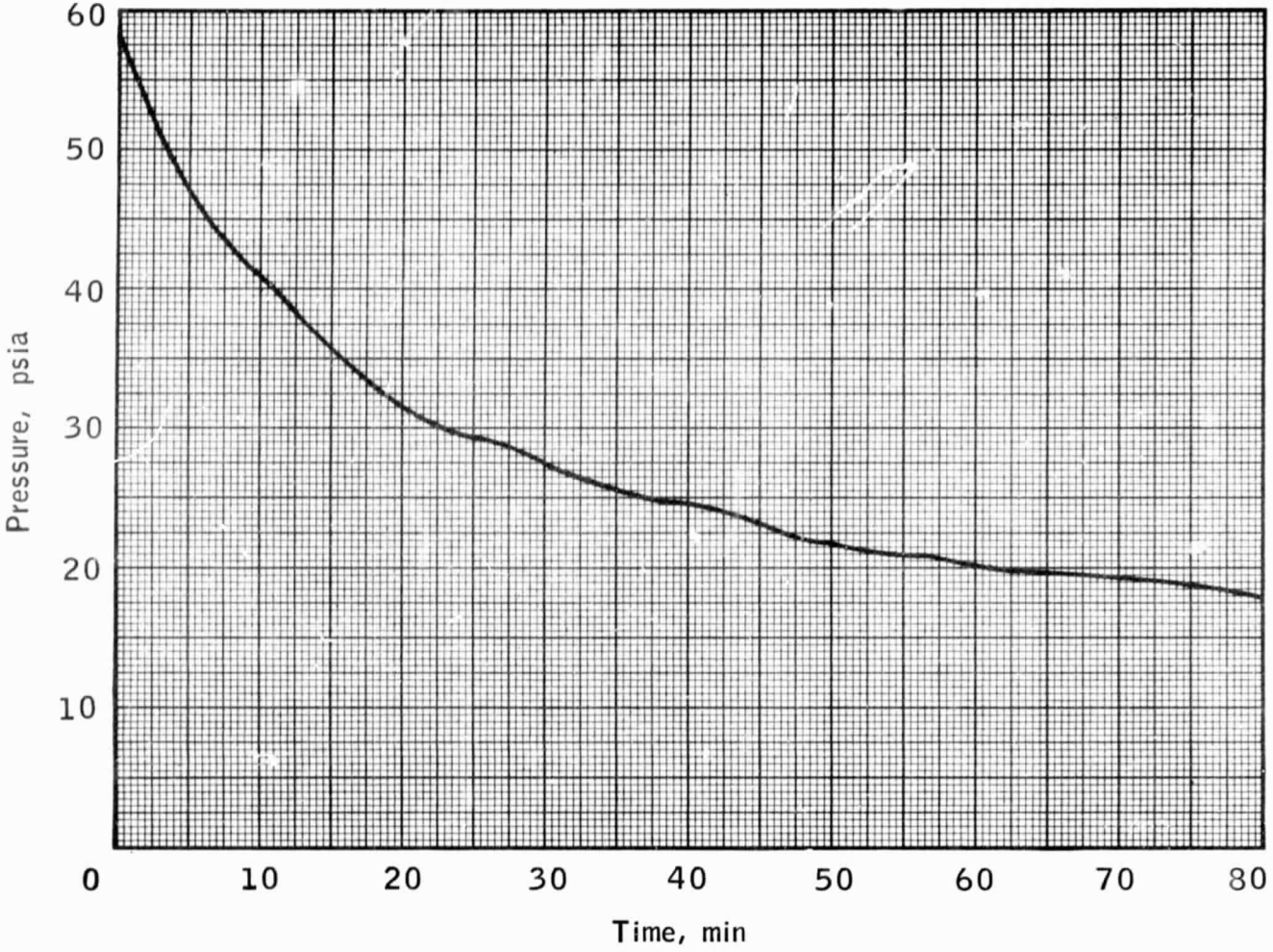



Figure 22.- Test E — descent tank pressure versus time.

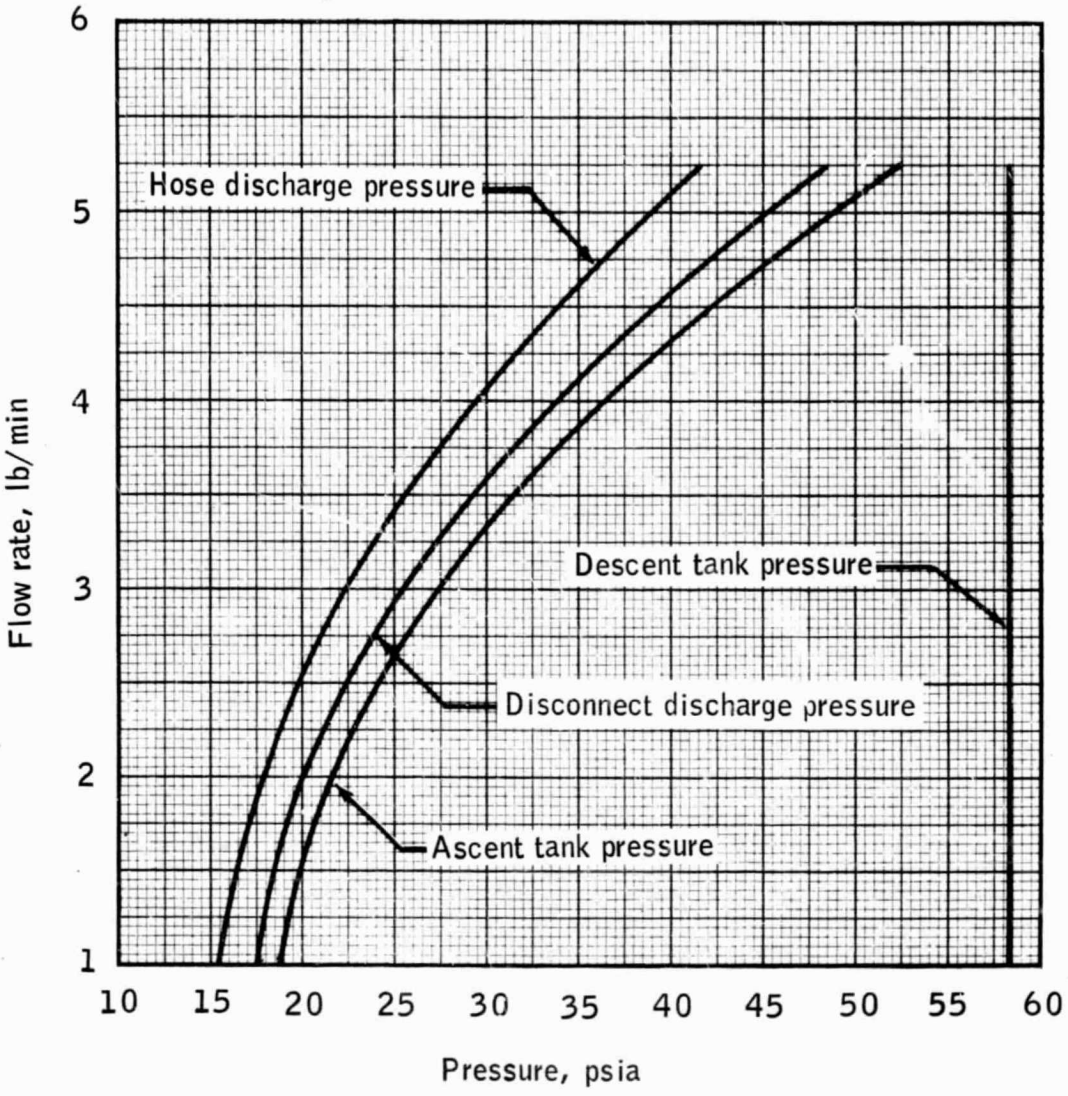



Figure 23.- Test F — flow rate versus ascent tank and line pressures.

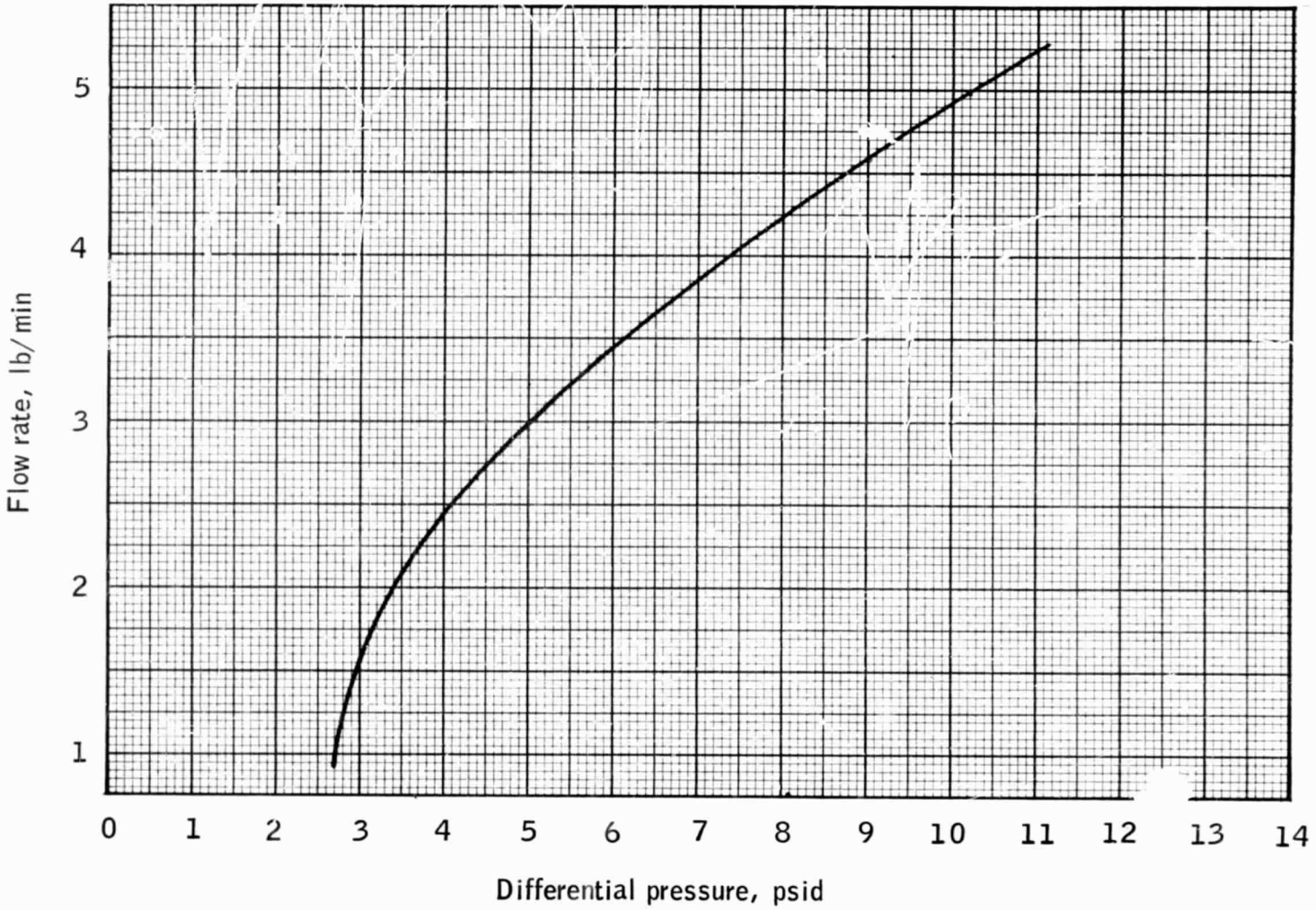



Figure 24.- Test F — flow rate versus ascent tank-hose discharge differential pressure.

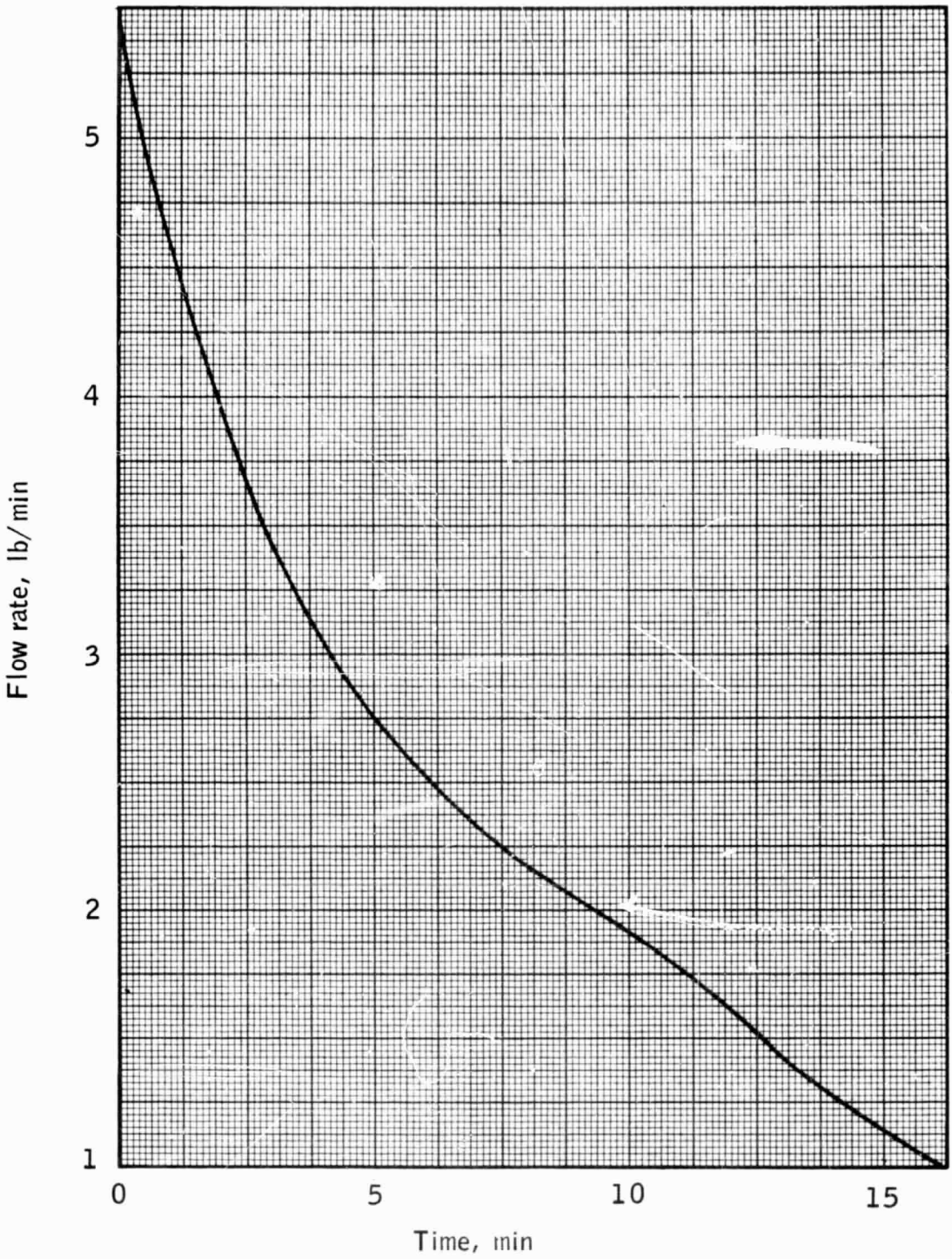



Figure 25.- Test F — line flow rate versus time.

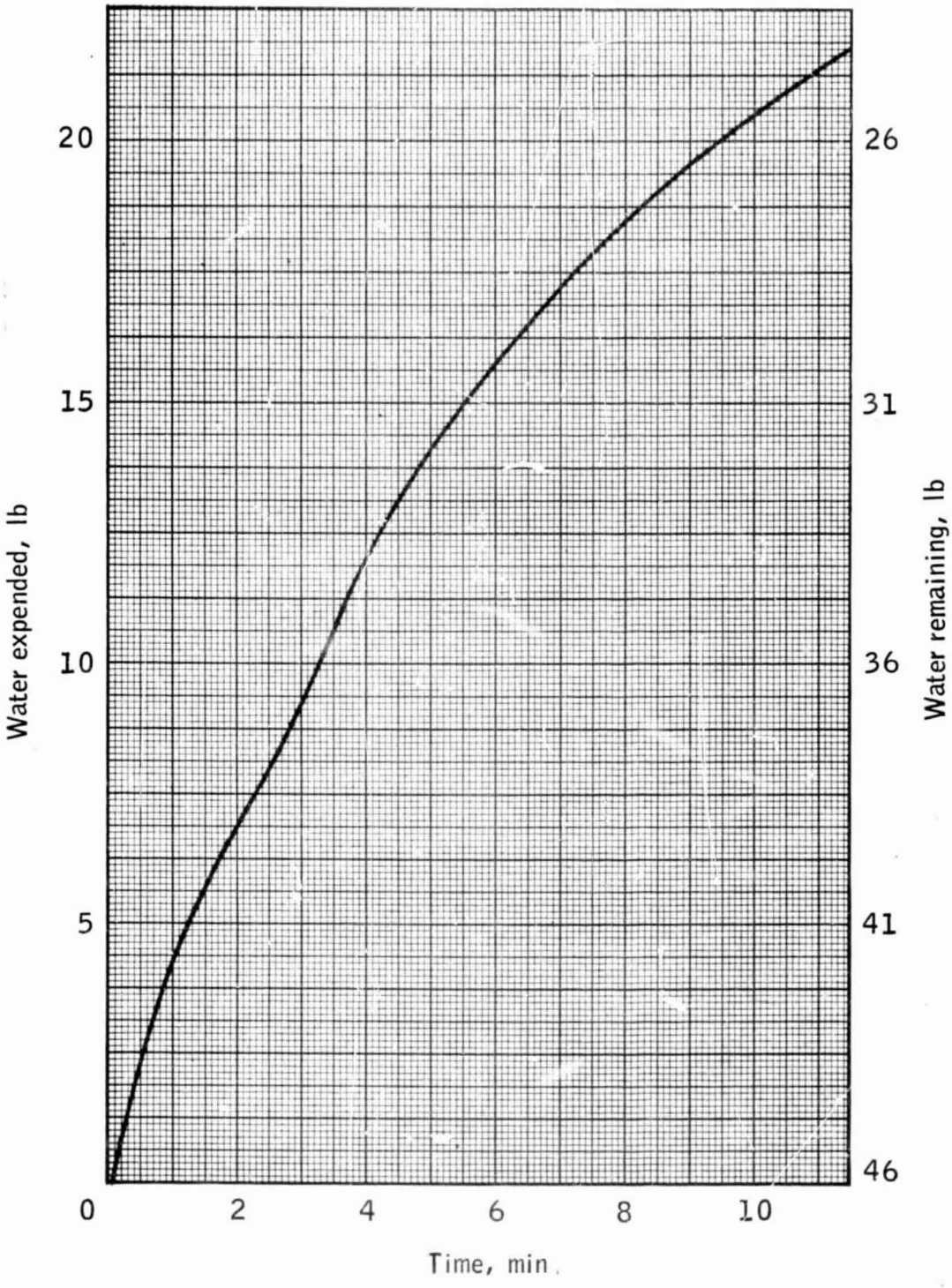



Figure 26.- Test F — ascent tank water expended versus time.

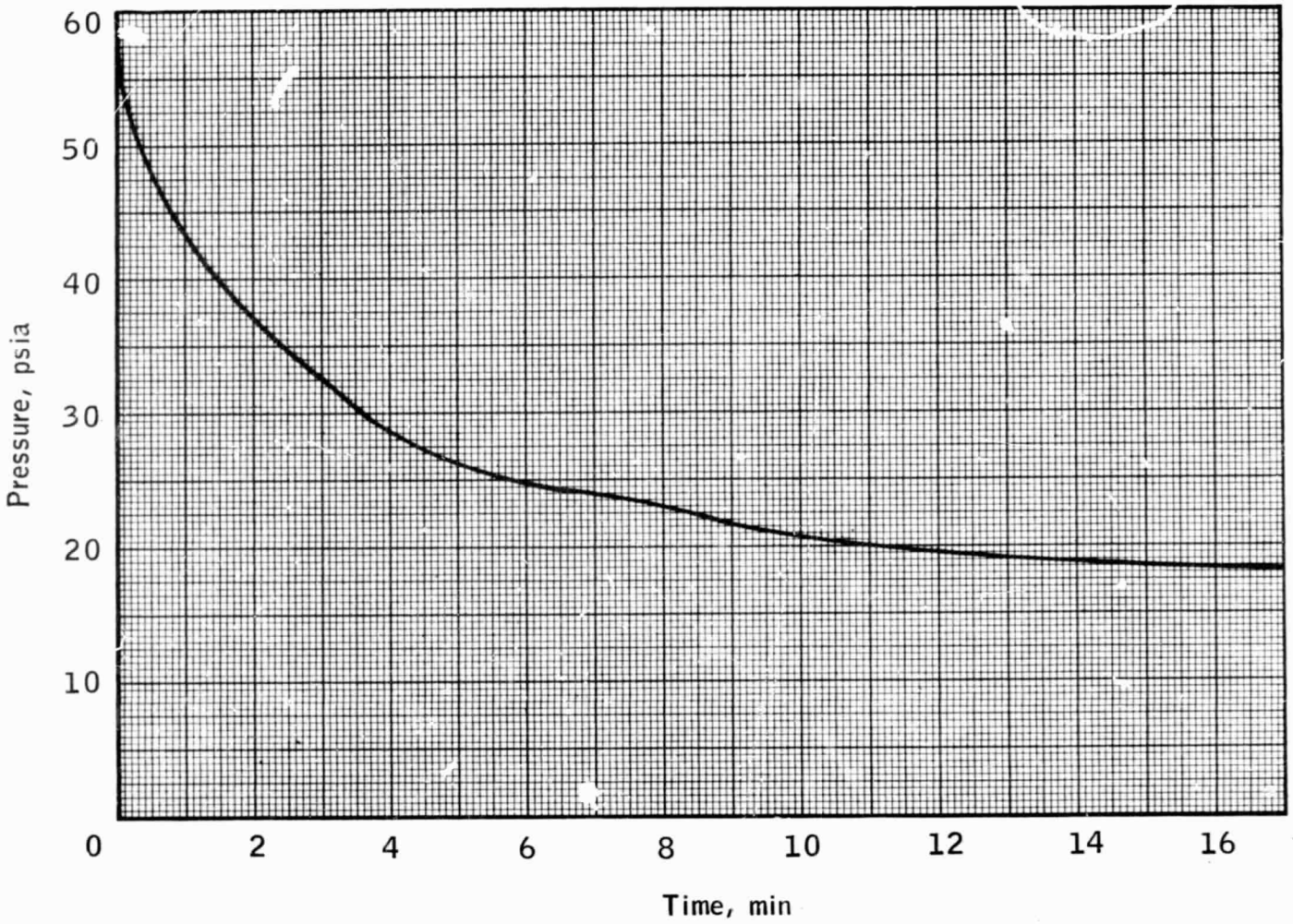



Figure 27.- Test F — ascent tank pressure versus time.

# APPENDIX A

## TEST DATA

TABLE A-I.- TEST A — CALIBRATION SWEEPS — DESCENT WATER TANK WITHOUT WATER DISPENSER/FIRE EXTINGUISHER, WITH HOKE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 48.5 | 15.0 | 0.5 | 0. | 14.8 |
| Notes: | | 1 | 48.8 | 49.6 | 33.7 | 5.35 | N/A |
| | | 2 | 48.8 | 49.6 | 33.0 | 9.11 | |
| | | 3 | 48.8 | 49.6 | 32.6 | 10.7 | |
| | | 4 | 48.7 | 47.7 | 32.5 | 21.4 | |
| | | 5 | 48.0 | 46.0 | 31.0 | 32.1 | |
| | | 6 | 47.2 | 43.3 | 28.0 | 42.8 | |
| | | 7 | 46.2 | 40.8 | 23.8 | 53.5 | |
| | | 8 | 44.7 | 36.8 | 20.0 | 64.2 | |
| | | 9 | 43.2 | 33.0 | 16.7 | 74.9 | |
| | | 10 | 41.5 | 28.0 | 12.0 | 85.6 | |
| | | 11 | 39.2 | 25.0 | 7.5 | 92.0 | |
| | | 12 | 36.5 | 23.5 | 7.0 | 85.6 | |
| | | 13 | 35.0 | 24.3 | 9.3 | 74.9 | |
| | | 14 | 34.4 | 26.3 | 12.5 | 64.2 | |
| | | 15 | 34.1 | 27.8 | 15.2 | 53.5 | |
| | | 16 | 34.1 | 29.2 | 17.2 | 42.8 | |
| | | 17 | 33.6 | 30.7 | 18.7 | 32.1 | |
| | | 18 | 33.4 | 31.4 | 20.0 | 21.4 | |
| | | 19 | 33.4 | 31.6 | 21.0 | 10.7 | |
| | | 20 | 33.4 | 32.1 | 21.5 | 9.11 | |
| | | 21 | 33.3 | 32.1 | 22.0 | 5.35 | |
| | | 22 | 33.3 | 33.0 | 20.5 | 5.35 | |
| | | 23 | 33.3 | 33.0 | 20.5 | 9.11 | |
| | | 24 | 33.0 | 33.0 | 20.4 | 10.7 | |
| | | 25 | 32.9 | 32.2 | 19.0 | 21.4 | |
| | | 26 | 32.9 | 30.8 | 17.5 | 32.10 | |

TABLE A-I.- TEST A — CALIBRATION SWEEPS — DESCENT WATER TANK WITHOUT WATER DISPENSER/FIRE EXTINGUISHER, WITH HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 48.5 | 15.0 | 0.5 | 0. | 14.8 |
| Notes: | | 27 | 32.8 | 29.3 | 15.5 | 42.8 | N/A |
| | | 28 | 32.0 | 26.5 | 12.5 | 53.5 | |
| | | 29 | 31.9 | 24.2 | 9.0 | 64.2 | |
| | | 30 | 31.2 | 21.4 | 6.5 | 73.0 | |
| | | 31 | 30.2 | 22.0 | 8.0 | 64.2 | |
| | | 32 | 30.2 | 24.1 | 11.5 | 53.5 | |
| | | 33 | 29.8 | 25.6 | 13.5 | 42.8 | |
| | | 34 | 29.7 | 26.4 | 15.0 | 32.1 | |
| | | 35 | 29.7 | 27.8 | 16.5 | 21.4 | |
| | | 36 | 29.6 | 27.9 | 17.5 | 10.7 | |
| | | 37 | 29.5 | 28.0 | 17.5 | 9.11 | |
| | | 38 | 29.5 | 28.5 | 17.5 | 5.35 | |
| | | 39 | 29.5 | 28.6 | 17.3 | 5.35 | |
| | | 40 | 29.5 | 28.6 | 17.0 | 9.11 | |
| | | 41 | 29.5 | 28.6 | 16.8 | 10.7 | |
| | | 42 | 29.5 | 28.0 | 15.5 | 21.4 | |
| | | 43 | 28.9 | 27.1 | 14.0 | 32.1 | |
| | | 44 | 29.9 | 25.8 | 11.7 | 42.8 | |
| | | 45 | 28.8 | 23.6 | 9.0 | 53.5 | |
| | | 46 | 28.8 | 20.8 | 5.5 | 64.2 | |
| | | 47 | 28.8 | 20.7 | 5.5 | 65.2 | |
| | | 48 | 27.2 | 20.0 | 5.0 | 64.2 | |
| | | 49 | 27.2 | 20.8 | 7.5 | 53.5 | |
| | | 50 | 27.1 | 22.1 | 10.0 | 42.8 | |
| | | 51 | 27.1 | 23.6 | 12.0 | 32.1 | |
| | | 52 | 27.0 | 25.0 | 13.0 | 21.4 | |

TABLE A-I.- TEST A — CALIBRATION SWEEPS — DESCENT WATER TANK WITHOUT WATER DISPENSER/FIRE EXTINGUISHER, WITH HOKE VALVE - Concluded

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 48.5 | 15.0 | 0.5 | 0. | 14.8 |
| Notes: | | 53 | 26.8 | 25.1 | 14.0 | 10.7 | N/A |
| | | 54 | 26.6 | 25.7 | 14.0 | 9.11 | |
| | | 55 | 26.6 | 25.8 | 14.0 | 5.35 | |
| | | 56 | 26.6 | 25.8 | 14.0 | 5.35 | |
| | | 57 | 26.6 | 25.8 | 14.0 | 9.11 | |
| | | 58 | 26.6 | 25.8 | 13.9 | 10.7 | |
| | | 59 | 26.5 | 25.2 | 12.5 | 21.4 | |
| | | 60 | 26.5 | 24.4 | 11.0 | 32.1 | |
| | | 61 | 26.4 | 23.0 | 9.0 | 42.8 | |
| | | 62 | 26.4 | 20.8 | 6.5 | 53.5 | |
| | | 63 | 26.3 | 19.3 | 5.0 | 58.0 | |
| | | 64 | 24.9 | 23.6 | 13.0 | 5.35 | |
| | | 65 | 24.9 | 23.6 | 12.5 | 9.11 | |
| | | 66 | 24.9 | 23.6 | 12.5 | 10.7 | |
| | | 67 | 24.9 | 23.5 | 11.5 | 21.4 | |
| | | 68 | 24.9 | 22.9 | 10.0 | 32.1 | |
| | | 69 | 24.9 | 21.4 | 8.0 | 42.8 | |
| | | 70 | 24.8 | 19.3 | 5.5 | 53.5 | |
| | | 71 | 24.1 | 18.7 | 5.0 | 54.5 | |
| | | 72 | 24.1 | 18.7 | 4.8 | 53.5 | |
| | | 73 | 24.0 | 19.1 | 7.0 | 42.8 | |
| | | 74 | 24.0 | 20.6 | 9.0 | 32.1 | |
| | | 75 | 24.0 | 21.3 | 10.0 | 21.4 | |
| | | 76 | 24.0 | 22.8 | 11.0 | 10.7 | |
| | | 77 | 24.0 | 22.8 | 11.0 | 9.11 | |
| | | 78 | 23.9 | 22.8 | 11.2 | 5.35 | |

TABLE A-II.- TEST B — CALIBRATION SWEEPS — ASCENT WATER TANK WITHOUT WATER DISPENSER/FREE EXTINGUISHER, WITH HOKE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 49.0 | 15.0 | 0.5 | 0. | 14.8 |
| Notes: | | 1 | 47.8 | 48.8 | 34.0 | 5.35 | N/A |
| | | 2 | 46.8 | 47.4 | 32.5 | 9.11 | |
| | | 3 | 45.5 | 46.2 | 31.5 | 10.7 | |
| | | 4 | 43.0 | 43.1 | 28.0 | 21.4 | |
| | | 5 | 37.2 | 36.8 | 21.5 | 32.10 | |
| | | 6 | 33.2 | 31.6 | 16.5 | 42.8 | |
| | | 7 | 29.0 | 26.3 | 11.0 | 53.5 | |
| | | 8 | 25.3 | 20.7 | 5.0 | 64.2 | |
| | | 9 | 22.6 | 18.4 | 3.5 | 58.0 | |
| | | 10 | 20.0 | 17.8 | 3.0 | 53.5 | |
| | | 11 | 18.8 | 17.7 | 3.0 | 42.8 | |
| | | 12 | 17.0 | 16.1 | 2.0 | 32.10 | |
| | | 13 | 16.5 | 16.1 | 2.0 | 21.4 | |
| | | 14 | 15.5 | 16.1 | 2.0 | 10.7 | |
| | | 15 | 15.5 | 16.1 | 2.0 | 9.11 | |
| | | 16 | 15.2 | 16.1 | 2.0 | 5.35 | |
| | | 17 | 15.5 | 14.8 | 2.5 | 5.35 | |
| | | 18 | 15.5 | 14.8 | 2.5 | 9.11 | |
| | | 19 | 15.2 | 14.8 | 2.5 | 10.7 | |
| | | 20 | 15.2 | 14.8 | 2.0 | 16.0 | |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 5 | 1 | 55.4 | 49.0 | 1.85 | 54.0 | 40.0 |
| 7/16/68 | 10 | 2 | 54.8 | 48.3 | 1.83 | 54.0 | 39.5 |
| Start time | 15 | 3 | 54.0 | 48.0 | 1.80 | 53.5 | 39.2 |
| 3:58 pm | 20 | 4 | 53.0 | 48.0 | 1.79 | 53.0 | 39.0 |
| Stop | 25 | 5 | 53.0 | 47.3 | 1.78 | 53.0 | 38.8 |
| 4:58 pm | 30 | 6 | 52.9 | 47.3 | 1.77 | 53.0 | 38.5 |
| 7/19/68 | 35 | 7 | 52.2 | 47.0 | 1.75 | 52.5 | 38.4 |
| Start | 40 | 8 | 52.0 | 46.8 | 1.74 | 52.5 | 38.3 |
| 9:20 am | 45 | 9 | 51.5 | 46.2 | 1.72 | 52.0 | 38.0 |
| Stop | 50 | 10 | 51.5 | 46.0 | 1.72 | 52.0 | 37.8 |
| 9:50 am | 65 | 11 | 51.2 | 46.0 | 1.70 | 51.75 | 37.3 |
| Cone of spray approx 4 to 6 feet diameter at 6 feet away | 80 | 12 | 50.5 | 45.3 | 1.67 | 51.0 | 37.0 |
| | 95 | 13 | 49.7 | 44.7 | 1.64 | 50.75 | 36.5 |
| | 110 | 14 | 49.1 | 44.1 | 1.60 | 50.0 | 36.2 |
| | 125 | 15 | 49.0 | 44.0 | 1.59 | 50.0 | 35.8 |
| | 140 | 16 | 48.3 | 43.4 | 1.58 | 49.5 | 35.3 |
| | 170 | 17 | 47.5 | 43.1 | 1.54 | 49.0 | 34.3 |
| | 200 | 18 | 46.3 | 41.2 | 1.47 | 48.0 | 34.0 |
| | 230 | 19 | 45.8 | 41.0 | 1.45 | 47.5 | 33.4 |
| | 260 | 20 | 45.0 | 41.0 | 1.40 | 47.0 | 33.0 |
| | 290 | 21 | 44.3 | 40.3 | 1.37 | 46.2 | 32.5 |
| | 320 | 22 | 43.8 | 39.6 | 1.35 | 46.0 | 32.0 |
| Notes: | 350 | 23 | 43.3 | 39.0 | 1.33 | 45.5 | 31.6 |
| | 380 | 24 | 42.6 | 38.9 | 1.30 | 45.0 | 31.3 |
| | 410 | 25 | 42.6 | 38.3 | 1.28 | 44.2 | 31.0 |
| | 440 | 26 | 42.0 | 38.1 | 1.26 | 44.0 | 30.8 |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 470 | 27 | 41.2 | 37.4 | 1.25 | 43.0 | 30.3 |
| | 500 | 28 | 41.0 | 37.4 | 1.23 | 42.5 | 30.0 |
| | 530 | 29 | 40.4 | 36.1 | 1.20 | 42.0 | 29.5 |
| | 560 | 30 | 40.1 | 36.1 | 1.18 | 41.8 | 29.0 |
| | 590 | 31 | 39.6 | 36.0 | 1.16 | 41.4 | 28.5 |
| | 620 | 32 | 38.6 | 34.9 | 1.14 | 41.0 | 28.4 |
| | 650 | 33 | 38.0 | 34.7 | 1.10 | 40.5 | 28.2 |
| | 680 | 34 | 37.9 | 34.7 | 1.08 | 40.0 | 27.9 |
| | 710 | 35 | 37.2 | 34.0 | 1.07 | 40.0 | 27.6 |
| | 740 | 36 | 37.0 | 33.3 | 1.06 | 39.5 | 27.4 |
| | 770 | 37 | 36.5 | 33.1 | 1.05 | 39.2 | 27.2 |
| | 800 | 38 | 36.2 | 33.1 | 1.04 | 38.9 | 26.9 |
| | 830 | 39 | 35.7 | 32.3 | 1.03 | 38.0 | 26.8 |
| | 860 | 40 | 35.4 | 31.9 | 1.0 | 38.0 | 26.8 |
| | 890 | 41 | 34.9 | 31.9 | 0.98 | 37.5 | 26.7 |
| | 920 | 42 | 34.8 | 31.8 | .97 | 37.2 | 26.5 |
| | 950 | 43 | 34.7 | 31.1 | .97 | 37.0 | 26.5 |
| | 980 | 44 | 34.0 | 31.0 | .96 | 37.0 | 26.5 |
| | 1010 | 45 | 33.1 | 29.7 | .95 | 36.5 | 26.1 |
| | 1040 | 46 | 33.0 | 29.7 | .92 | 36.0 | 25.8 |
| | 1070 | 47 | 32.3 | 29.7 | .90 | 36.0 | 25.6 |
| | 1100 | 48 | 32.2 | 29.6 | .90 | 36.0 | 25.4 |
| | 1130 | 49 | 31.8 | 28.9 | .85 | 35.0 | 25.1 |
| | 1160 | 50 | 31.8 | 28.0 | .83 | 34.0 | 24.8 |
| | 1190 | 51 | 30.9 | 28.0 | .81 | 34.0 | 24.5 |
| | 1220 | 52 | 30.9 | 28.0 | .80 | 33.5 | 24.3 |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 56.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 1250 | 53 | 30.8 | 28.0 | 0.80 | 33.5 | 24.0 |
| | 1280 | 54 | 30.1 | 27.2 | .78 | 33.0 | 23.8 |
| | 1310 | 55 | 30.0 | 27.2 | .75 | 32.5 | 23.5 |
| | 1340 | 56 | 29.2 | 26.6 | .73 | 32.0 | 23.3 |
| | 1370 | 57 | 29.2 | 26.5 | .725 | 32.0 | 23.0 |
| | 1400 | 58 | 29.0 | 26.5 | .73 | 31.5 | 22.8 |
| | 1430 | 59 | | 26.5 | .72 | 31.2 | 22.6 |
| | 1460 | 60 | 29.0 | 26.0 | .71 | 31.0 | 22.5 |
| | 1490 | 61 | | 25.9 | .70 | 31.0 | 22.5 |
| | 1520 | 62 | | 25.9 | .70 | 30.5 | 22.5 |
| | 1550 | 63 | 28.0 | 25.1 | .70 | 30.5 | 22.4 |
| | 1580 | 64 | 28.0 | 25.1 | .70 | 30.0 | 22.1 |
| | 1610 | 65 | | 25.1 | .70 | 29.5 | 22.1 |
| | 1640 | 66 | 27.0 | 24.5 | .70 | 29.0 | 22.1 |
| | 1670 | 67 | | 24.3 | .70 | 28.7 | 21.9 |
| | 1700 | 68 | | 24.0 | .70 | 28.0 | 21.5 |
| | 1730 | 69 | | 23.8 | .67 | 28.0 | 21.4 |
| | 1760 | 70 | 26.0 | 23.7 | .72 | 28.0 | 21.3 |
| | 1790 | 71 | | 23.0 | .71 | 28.0 | 21.0 |
| | 1820 | 72 | | 23.0 | .70 | 27.5 | 21.0 |
| | 1850 | 73 | 26.0 | 23.0 | .72 | 27.0 | 20.8 |
| | 1880 | 74 | | 22.9 | .70 | 27.0 | 20.5 |
| | 1910 | 75 | 25.0 | 22.9 | .70 | 26.5 | 20.5 |
| | 1940 | 76 | | 22.9 | .69 | 26.0 | 20.4 |
| | 1970 | 77 | | 22.9 | .72 | 26.0 | 20.4 |
| | 2000 | 78 | 25.0 | 22.3 | .71 | 26.0 | 20.3 |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 2030 | 79 | | 22.0 | 0.74 | 26.5 | 20.1 |
| | 2060 | 80 | | 22.0 | .70 | 26.0 | 20.2 |
| | 2090 | 81 | 24.3 | 22.0 | .70 | 26.0 | 20.3 |
| | 2150 | 82 | 24.0 | 22.8 | .70 | 26.0 | 19.9 |
| | 2210 | 84 | 24.0 | 22.0 | .71 | 25.5 | 19.9 |
| | 2270 | 86 | 24.0 | 22.0 | .70 | 25.0 | 19.9 |
| | 2330 | 88 | 24.0 | 22.0 | .70 | 24.9 | 19.6 |
| | 2390 | 90 | 24.0 | 22.0 | .70 | 23.5 | 19.5 |
| | 2450 | 92 | 23.0 | 21.3 | .70 | 23.8 | 19.3 |
| | 2510 | 94 | 23.0 | 21.2 | .70 | 23.5 | 19.2 |
| | 2570 | 96 | 22.4 | 21.2 | .69 | 23.5 | 18.8 |
| | 2630 | 98 | 22.4 | 21.2 | .69 | 22.9 | 18.7 |
| Flow appears adequate | 2690 | 100 | 21.6 | 20.6 | .70 | 22.0 | 18.6 |
| | 2750 | 102 | 21.6 | 20.6 | .70 | 22.0 | 18.4 |
| | 2810 | 104 | 21.6 | 20.6 | .70 | 21.0 | 18.2 |
| | 2870 | 106 | 21.6 | 20.6 | .73 | 21.0 | 18.3 |
| | 2930 | 108 | 21.6 | 20.6 | .70 | 20.2 | 18.0 |
| | 2990 | 110 | 21.6 | 20.4 | .70 | 20.0 | 17.8 |
| | 3050 | 112 | 20.8 | 20.4 | .68 | 19.8 | 17.7 |
| | 3110 | 114 | 20.8 | 20.4 | .70 | 19.2 | 17.6 |
| | 3170 | 116 | 20.8 | 20.4 | .70 | 19.0 | 17.5 |
| | 3230 | 118 | 20.8 | 19.9 | .71 | 18.8 | 17.4 |
| | 3290 | 120 | 20.8 | 19.9 | .68 | 18.5 | 17.4 |
| | 3350 | 122 | 20.7 | 19.9 | .70 | 18.2 | 17.3 |
| | 3410 | 124 | 20.0 | 19.2 | .70 | 17.5 | 17.2 |
| | 3470 | 126 | 20.0 | 19.2 | .72 | 17.2 | 17.1 |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| | 3530 | 128 | 20.0 | 19.0 | 0.69 | 17.0 | 17.0 |
| Erratic readings | 3590 | 130 | 20.0 | 19.0 | .70 | 16.8 | 16.8 |
| | 3650 | 132 | 20.0 | 19.0 | .70 | 16.2 | 16.6 |
| | 3710 | 134 | 20.0 | 18.6 | .69 | 16.0 | 16.6 |
| | 3770 | 136 | 19.5 | 18.3 | .72 | 15.5 | 16.5 |
| | 3830 | 138 | 19.5 | 18.3 | .70 | 15.0 | 16.4 |
| Notes: | 3890 | 140 | 19.5 | 18.3 | .68 | 15.0 | 16.3 |
| | 3950 | 142 | 18.9 | 18.3 | .72 | 14.5 | 16.2 |
| Erratic flow | 4010 | 146 | 18.9 | 18.3 | .71 | 14.0 | 16.1 |
| Cone approx 1 to 3 inches diameter at 1 foot away | 4070 | 148 | 18.9 | 18.3 | .72 | 13.9 | 16.0 |
| | 4130 | 150 | 18.9 | 18.3 | .71 | 13.8 | 16.0 |
| | 4190 | 152 | 18.9 | 18.3 | .70 | 13.5 | 15.9 |
| | 4250 | 154 | 18.9 | 18.3 | .72 | 12.9 | 15.8 |
| | 4310 | 156 | 18.6 | 18.3 | .70 | 12.2 | 15.7 |
| | 4370 | 158 | 18.6 | 18.3 | .70 | 12.2 | 15.7 |
| | 4430 | 160 | 18.6 | 18.0 | .70 | 12.0 | 15.6 |
| | 4490 | 162 | 18.6 | 18.0 | .73 | 11.5 | 15.5 |
| | 4550 | 164 | 18.0 | 18.0 | .72 | 10.8 | 15.4 |
| | 4610 | 166 | 18.0 | 17.4 | .70 | 10.0 | 15.3 |
| | 4670 | 168 | 18.0 | 17.4 | .74 | 10.0 | 15.2 |
| | 4730 | 170 | 18.0 | 17.4 | .66 | 10.0 | 15.2 |
| | 4790 | 172 | 18.0 | 17.4 | .72 | 9.0 | 15.1 |
| | 4850 | 174 | 18.0 | 17.4 | .72 | 9.0 | 15.1 |
| | 4910 | 176 | 18.0 | 17.4 | .70 | 8.0 | 15.1 |
| | 4970 | 178 | 18.0 | 17.4 | .68 | 8.0 | 15.0 |
| | 5030 | 180 | 18.0 | 17.4 | .70 | 7.0 | 15.0 |

TABLE A-III.- TEST C — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITH HOKE VALVE - Concluded

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Hoke valve press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 5090 | 182 | 18.0 | 17.4 | 0.70 | 5.0 | 15.0 |
| | 5150 | 184 | 18.0 | 17.4 | .72 | 5.0 | 15.0 |
| | 5210 | 186 | 18.0 | 17.4 | .70 | 5.0 | 15.0 |
| | 5270 | 188 | 18.0 | 17.4 | .78 | 5.0 | 14.9 |
| No significant flow | 5330 | 190 | 18.0 | 17.4 | .07 | 4.0 | 14.9 |
| | 5390 | 192 | 17.9 | 17.4 | .71 | 3.0 | 14.8 |
| Test concluded | | | | | | | |

TABLE A-IV.- TEST D — ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 5 | 1 | 50.5 | 46.3 | 0.32 | 54.0 | 40.0 |
| 7/19/68 | 10 | 2 | 47.0 | 43.7 | .30 | 51.0 | 38.2 |
| Start 2:03 pm | 15 | 3 | 44.0 | 40.8 | .29 | 49.0 | 36.2 |
| Stop 2:13 pm | 20 | 4 | 41.0 | 38.4 | .28 | 46.0 | 33.2 |
| | 30 | 5 | 39.0 | 37.0 | .28 | 44.0 | 32.0 |
| Cone of spray approx 4 to 6 feet diameter at 6 feet away | 40 | 6 | 37.2 | 34.9 | .27 | 42.0 | 30.7 |
| | 50 | 7 | 36.0 | 34.0 | .27 | 41.0 | 29.8 |
| | 60 | 8 | 34.9 | 32.8 | .27 | 40.0 | 29.0 |
| | 70 | 9 | 34.0 | 32.0 | .27 | 39.0 | 28.3 |
| | 80 | 10 | 33.4 | 31.9 | .26 | 38.0 | 27.8 |
| | 90 | 11 | 32.1 | 29.9 | .26 | 37.0 | 27.0 |
| | 100 | 12 | 31.2 | 29.8 | .26 | 36.0 | 26.2 |
| | 110 | 13 | 30.6 | 29.0 | .25 | 35.0 | 25.7 |
| | 120 | 14 | 29.8 | 28.2 | .25 | 34.0 | 24.9 |
| | 130 | 15 | 29.0 | 26.9 | .25 | 33.0 | 24.5 |
| | 140 | 16 | 28.0 | 26.9 | .25 | 32.0 | 24.0 |
| | 150 | 17 | 27.8 | 26.1 | .25 | 32.0 | 23.7 |
| | 160 | 18 | 27.2 | 25.3 | .24 | 31.0 | 23.3 |
| | 170 | 19 | 26.7 | 25.2 | .25 | 30.5 | 23.0 |
| | 180 | 20 | 26.3 | 24.9 | .25 | 30.0 | 22.7 |
| | 190 | 21 | 25.9 | 24.0 | .25 | 29.5 | 22.3 |
| | 200 | 22 | 25.7 | 24.0 | .25 | 29.0 | 21.9 |
| | 210 | 23 | 25.1 | 23.2 | .24 | 28.0 | 21.6 |
| | 220 | 24 | 24.8 | 23.2 | .25 | 27.0 | 21.6 |
| | 230 | 25 | 24.2 | 23.2 | .25 | 27.0 | 21.1 |
| | 240 | 26 | 24.1 | 23.2 | .25 | 26.5 | 20.9 |

TABLE A-IV.- TEST D — ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 250 | 27 | 23.8 | 22.3 | 0.25 | 26.0 | 20.8 |
| | 260 | 28 | 23.7 | 21.8 | .25 | 26.0 | 20.6 |
| | 270 | 29 | 23.3 | 21.8 | .25 | 25.0 | 20.3 |
| | 280 | 30 | 23.2 | 21.8 | .25 | 24.0 | 20.1 |
| | 290 | 31 | 22.8 | 21.0 | .25 | 23.5 | 19.9 |
| | 300 | 32 | 22.4 | 21.0 | .26 | 23.5 | 19.5 |
| | 310 | 33 | 22.0 | 21.0 | .25 | 23.0 | 19.3 |
| | 320 | 34 | 21.9 | 21.0 | .25 | 22.0 | 19.0 |
| | 330 | 35 | 21.4 | 20.2 | .26 | 22.0 | 18.9 |
| | 340 | 36 | 21.4 | 20.2 | .24 | 21.0 | 18.7 |
| Erratic flow cone spray approx 2 to 3 inches diameter at 1 foot away | 350 | 37 | 21.0 | 20.2 | .26 | 21.5 | 18.5 |
| | 360 | 38 | 21.0 | 19.5 | .25 | 20.0 | 18.4 |
| | 370 | 39 | 20.6 | 19.5 | .25 | 26.0 | 18.2 |
| | 380 | 40 | 20.5 | 19.5 | .26 | 19.5 | 18.1 |
| | 390 | 41 | 20.5 | 19.5 | .26 | 19.0 | 17.9 |
| | 400 | 42 | 20.2 | 19.5 | .26 | 19.0 | 17.8 |
| | 410 | 43 | 20.1 | 19.5 | .24 | 18.0 | 17.6 |
| | 420 | 44 | 20.1 | 19.5 | .26 | 17.5 | 17.6 |
| | 430 | 45 | 19.6 | 19.5 | .26 | 17.0 | 17.5 |
| | 440 | 46 | 19.6 | 19.5 | .26 | 17.0 | 17.4 |
| | 450 | 47 | 19.6 | 18.9 | .26 | 17.0 | 17.3 |
| | 460 | 48 | 19.0 | 18.9 | .26 | 16.0 | 17.2 |
| | 470 | 49 | 19.0 | 18.2 | .26 | 16.0 | 17.0 |
| | 480 | 50 | 19.0 | 18.2 | .26 | 15.0 | 16.9 |
| | 490 | 51 | 19.0 | 18.2 | .26 | 15.0 | 16.8 |
| | 500 | 52 | 18.9 | 18.2 | .26 | 14.0 | 16.7 |

TABLE A-IV.- TEST D - ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Concluded

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 14.7 | 0. | 0. | 14.7 |
| Notes: | 510 | 53 | 18.9 | 18.2 | .26 | 13.5 | 16.6 |
| | 520 | 54 | 18.8 | 18.2 | .26 | 13.0 | 16.5 |
| | 530 | 55 | 18.8 | 17.5 | .26 | 12.0 | 16.4 |
| | 540 | 56 | 18.8 | 17.5 | .25 | 12.0 | 16.3 |
| | 550 | 57 | 18.8 | 17.5 | .25 | 12.0 | 16.2 |
| | 560 | 58 | 18.3 | 17.5 | .25 | 11.0 | 16.1 |
| No significant flow | 570 | 59 | 18.3 | 17.5 | .24 | 10.5 | 15.9 |
| | 580 | 60 | 18.2 | 17.5 | .25 | 10.0 | 15.8 |
| Test concluded | | | | | | | |

TABLE A-V.- TEST E — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOSE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 57.7 | 0. | 0. | 14.7 |
| Notes: | 5 | 1 | 57.9 | 51.7 | | 58.0 | 45.0 |
| 7/29/68 | 10 | 2 | 57.0 | 51.0 | | 57.0 | 43.5 |
| Start 2:02 pm | 15 | 3 | 57.0 | 50.7 | | 57.0 | 43.0 |
| Stop 3:25 pm | 20 | 4 | 56.2 | 50.1 | | 56.0 | 42.9 |
| | 25 | 5 | 56.0 | 50.0 | | 56.0 | 42.5 |
| Spray cone approx 4 to 6 feet diameter at 6 feet away | 30 | 6 | 55.3 | 49.5 | | 56.0 | 42.3 |
| | 35 | 7 | 55.1 | 49.2 | | 56.0 | 42.0 |
| | 40 | 8 | 55.1 | 49.1 | | 56.0 | 41.9 |
| | 45 | 9 | 54.7 | 49.1 | | 56.0 | 41.7 |
| | 50 | 10 | 54.6 | 49.0 | | 56.0 | 41.5 |
| | 65 | 11 | 53.9 | 48.4 | | 55.5 | 41.3 |
| | 80 | 12 | 53.8 | 47.8 | | 55.0 | 40.8 |
| | 95 | 13 | 53.0 | 47.8 | | 55.0 | 40.5 |
| | 110 | 14 | 52.1 | 47.0 | 0.35 | 54.5 | 40.0 |
| | 125 | 15 | 52.1 | 46.9 | | 54.0 | 39.6 |
| | 140 | 16 | 51.3 | 46.3 | .33 | 54.0 | 39.4 |
| | 170 | 17 | 51.3 | 46.2 | | 53.8 | 39.2 |
| | 200 | 18 | 49.8 | 45.0 | .33 | 52.5 | 38.3 |
| | 230 | 19 | 49.0 | 44.1 | | 52.0 | 37.6 |
| | 260 | 20 | 48.1 | 43.5 | .31 | 51.2 | 37.0 |
| | 290 | 21 | 47.3 | 43.0 | | 50.5 | 36.5 |
| | 320 | 22 | 47.0 | 42.8 | .30 | 50.2 | 36.2 |
| | 350 | 23 | 46.4 | 42.0 | | 49.0 | 35.8 |
| | 380 | 24 | 45.7 | 41.3 | .30 | 49.0 | 35.2 |
| | 410 | 25 | 45.0 | 40.9 | | 48.5 | 34.6 |
| | 440 | 26 | 44.0 | 40.3 | .29 | 48.0 | 34.2 |

TABLE A-V.- TEST E — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUSIHER, WITHOUT HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 57.7 | 0. | 0. | 14.7 |
| Notes: | 470 | 27 | 43.9 | 39.9 | | 47.0 | 33.8 |
| | 500 | 28 | 43.4 | 39.1 | 0.28 | 46.5 | 33.2 |
| | 530 | 29 | 42.2 | 38.6 | | 46.0 | 33.0 |
| | 560 | 30 | 42.1 | 38.4 | .27 | 45.5 | 32.6 |
| | 590 | 31 | 41.4 | 37.0 | | 45.0 | 32.2 |
| | 620 | 32 | 40.9 | 37.0 | .26 | 44.5 | 32.0 |
| | 650 | 33 | 40.7 | 36.6 | | 44.0 | 31.5 |
| | 680 | 34 | 39.9 | 36.3 | .26 | 44.0 | 31.2 |
| | 710 | 35 | 39.0 | 36.1 | | 43.5 | 30.8 |
| | 740 | 36 | 38.2 | 35.5 | .26 | 42.5 | 30.2 |
| | 770 | 37 | 37.7 | 34.9 | | 42.0 | 29.9 |
| | 810 | 38 | 37.3 | 34.0 | .26 | 41.5 | 29.5 |
| | 840 | 39 | 37.0 | 34.0 | .26 | 41.0 | 29.2 |
| | 870 | 40 | 36.7 | 33.3 | | 41.0 | 28.9 |
| | 900 | 41 | 36.0 | 33.3 | .26 | 40.5 | 28.7 |
| | 930 | 42 | 36.0 | 32.9 | .25 | 40.0 | 28.5 |
| | 960 | 43 | 35.0 | 32.0 | .25 | 39.5 | 28.0 |
| | 990 | 44 | 35.0 | 32.0 | | 39.5 | 27.8 |
| | 1020 | 45 | 34.3 | 32.0 | .25 | 39.0 | 27.7 |
| | 1050 | 46 | 34.2 | 31.1 | | 39.0 | 27.5 |
| | 1080 | 47 | 33.7 | 31.1 | .25 | 38.5 | 27.2 |
| | 1110 | 48 | 33.7 | 30.7 | | 38.5 | 27.0 |
| | 1140 | 49 | 33.0 | 30.7 | .25 | 38.0 | 26.7 |
| | 1170 | 50 | 32.9 | 29.9 | | 37.5 | 26.5 |
| | 1230 | 51 | 32.0 | 29.0 | .25 | 37.0 | 26.0 |
| | 1290 | 52 | 31.9 | 29.0 | | 36.5 | 25.7 |

TABLE A-V.- TEST E — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 57.7 | 0. | 0. | 14.7 |
| Notes: | 1350 | 53 | 31.1 | 28.1 | 0.25 | 36.0 | 25.4 |
| | 1410 | 54 | 30.3 | 28.1 | | 35.5 | 25.0 |
| | 1470 | 55 | 30.2 | 27.3 | .24 | 35.0 | 24.7 |
| | 1530 | 56 | 29.7 | 26.8 | | 34.5 | 24.4 |
| | 1590 | 57 | 29.4 | 26.8 | .23 | 34.0 | 24.1 |
| | 1650 | 58 | 28.6 | 26.0 | .23 | 33.5 | 23.5 |
| | 1710 | 59 | | | | 33.0 | 23.3 |
| | 1770 | 60 | 27.9 | 25.2 | .23 | 32.0 | 22.9 |
| | 1830 | 61 | | | | 31.5 | 22.7 |
| | 1890 | 62 | 27.0 | 24.6 | .22 | 31.0 | 22.5 |
| | 1950 | 63 | | | | 30.5 | 22.3 |
| | 2010 | 64 | | | | 30.0 | 22.0 |
| | 2070 | 65 | 26.2 | 23.8 | .21 | 29.5 | 21.7 |
| | 2130 | 66 | | | | 29.0 | 21.6 |
| | 2190 | 67 | | | | 29.0 | 21.4 |
| | 2250 | 68 | 25.0 | 23.0 | .21 | 28.5 | 21.2 |
| | 2310 | 69 | | | | 28.0 | 21.0 |
| | 2370 | 70 | 24.9 | 22.4 | .20 | 27.5 | 21.0 |
| | 2430 | 71 | | | | 27.0 | 20.8 |
| | 2490 | 72 | | | | 27.0 | 20.6 |
| | 2550 | 73 | 24.0 | 22.2 | .21 | 27.0 | 20.5 |
| | 2610 | 74 | | | | 26.5 | 20.3 |
| | 2670 | 75 | | | | 26.0 | 20.2 |
| | 2730 | 76 | 23.9 | 21.8 | .21 | 25.5 | 20.0 |
| | 2790 | 77 | 23.0 | 21.6 | .21 | 25.0 | 19.8 |
| | 2850 | 78 | | | | 25.0 | 19.7 |

TABLE A-V.- TEST E — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 57.7 | 0. | 0. | 14.7 |
| Notes: | 2910 | 79 | 23.0 | 21.4 | 0.21 | 24.5 | 19.5 |
| | 2970 | 80 | | | | 24.0 | 19.5 |
| | 3030 | 81 | 22.4 | 20.7 | .21 | 24.0 | 19.3 |
| | 3090 | 82 | | | | 23.5 | 19.1 |
| Somewhat erratic readings | 3150 | 83 | 21.7 | 20.7 | .20 | 23.5 | 19.0 |
| | 3210 | 84 | | | | 23.5 | 18.8 |
| | 3270 | 85 | 21.7 | 20.0 | .21 | 22.5 | 18.8 |
| | 3330 | 86 | | | | 22.5 | 18.7 |
| | 3390 | 87 | 21.7 | 20.0 | .20 | 22.0 | 18.5 |
| | 3450 | 88 | | | | 22.0 | 18.5 |
| | 3510 | 89 | 20.9 | 20.0 | .21 | 21.5 | 18.4 |
| | 3570 | 90 | | | | 21.0 | 18.2 |
| | 3630 | 91 | 20.9 | 20.0 | .21 | 20.5 | 18.2 |
| | 3690 | 92 | | | | 20.0 | 18.0 |
| | 3750 | 93 | | | | 19.5 | 18.0 |
| | 3810 | 94 | 20.8 | 19.2 | .20 | 19.5 | 17.9 |
| | 3870 | 95 | | | | 19.0 | 17.7 |
| | 3930 | 96 | 19.9 | 19.1 | .21 | 19.0 | 17.6 |
| | 3990 | 97 | 19.9 | 19.1 | | 18.5 | 17.5 |
| | 4050 | 98 | | | .21 | 18.0 | 17.4 |
| | 4110 | 99 | 19.9 | 19.1 | | 17.5 | 17.4 |
| | 4170 | 100 | 19.9 | | .20 | 17.5 | 17.3 |
| | 4230 | 101 | 19.8 | 19.1 | | 17.0 | 17.2 |
| Erratic flow | 4290 | 102 | | | | 17.0 | 17.1 |
| | 4350 | 103 | 19.8 | 19.1 | .20 | 16.5 | 17.0 |

TABLE A-V.- TEST E — DESCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Concluded

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 58.0 | 57.0 | 0. | 0. | 14.7 |
| Cone spray approx 2 to 3 inches diameter at 1 foot away | 4410 | 104 | | | | 16.0 | 16.9 |
| | 4470 | 105 | 19.0 | 18.5 | 0.20 | 16.0 | 16.8 |
| | 4530 | 106 | | | | 16.0 | 16.8 |
| | 4590 | 107 | 19.0 | 18.5 | .21 | 15.0 | 16.7 |
| | 4650 | 108 | | | | 15.0 | 16.5 |
| | 4710 | 109 | 19.0 | 18.5 | .20 | 14.0 | 16.5 |
| | 4770 | 110 | | | | 14.0 | 16.4 |
| | 4830 | 111 | 18.2 | 18.3 | .20 | 14.0 | 16.3 |
| | 4890 | 112 | 18.2 | 18.3 | | 13.5 | 16.2 |
| | 4950 | 113 | 18.2 | 18.3 | .20 | 13.0 | 16.2 |
| Flow not adequate | 5010 | 114 | | | | | |
| Test concluded | | | | | | | |

TABLE A-VI.- TEST F — ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 59.0 | 56.2 | 0. | 0. | 14.7 |
| Notes: | 10 | 1 | 53.2 | 49.2 | 0.33 | 56.0 | 42.0 |
| 7/29/68 | 20 | 2 | 49.8 | 46.7 | .33 | 54.0 | 39.7 |
| Start 11:45 am | 30 | 3 | 48.0 | 44.2 | .31 | 52.0 | 38.0 |
| Stop 12:02 pm | 40 | 4 | 46.8 | 42.8 | .31 | 51.0 | 36.8 |
| | 50 | 5 | 45.5 | 42.0 | .31 | 50.0 | 35.8 |
| Spray cone | 60 | 6 | 44.0 | 40.6 | .31 | 49.0 | 35.0 |
| approx 5 to 6 feet | 70 | 7 | 42.7 | 39.2 | .30 | 47.0 | 34.0 |
| diameter at | 80 | 8 | 41.4 | 38.3 | .30 | 46.0 | 33.3 |
| 6 feet away | 90 | 9 | 40.4 | 37.6 | .29 | 45.0 | 32.5 |
| | 100 | 10 | 39.0 | 36.9 | .29 | 44.0 | 31.4 |
| | 110 | 11 | 38.0 | 35.5 | .28 | 43.5 | 30.5 |
| | 120 | 12 | 37.4 | 34.8 | .28 | 43.0 | 29.9 |
| | 130 | 13 | 36.8 | 34.0 | .26 | 42.0 | 29.2 |
| | 140 | 14 | 36.0 | 33.4 | .26 | 41.0 | 28.7 |
| | 150 | 15 | 35.3 | 33.0 | .27 | 40.0 | 28.2 |
| | 160 | 16 | 35.0 | 32.5 | .27 | 39.0 | 27.7 |
| | 170 | 17 | 34.0 | 31.8 | .26 | 38.0 | 27.4 |
| | 180 | 18 | 33.3 | 31.1 | .26 | 37.0 | 26.7 |
| | 190 | 19 | 32.0 | 28.8 | .26 | 36.0 | 25.7 |
| | 200 | 20 | 31.0 | 28.8 | .25 | 36.0 | 25.5 |
| | 210 | 21 | 30.0 | 28.0 | .25 | 35.0 | 25.0 |
| | 220 | 22 | 30.0 | 28.0 | .25 | 34.0 | 24.5 |
| | 230 | 23 | 29.0 | 27.3 | .25 | 32.0 | 24.3 |
| | 240 | 24 | 28.5 | 27.3 | .25 | 32.0 | 23.7 |
| | 250 | 25 | 28.0 | 26.9 | .25 | 32.0 | 23.5 |
| | 260 | 26 | 28.0 | 26.6 | .25 | 31.0 | 23.2 |

TABLE A-VI.- TEST F — ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Continued

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 59.0 | 56.2 | 0. | 0. | 14.7 |
| Notes: | 270 | 27 | 27.7 | 25.2 | .25 | 31.0 | 23.0 |
| | 280 | 28 | 27.2 | 25.2 | .25 | 30.0 | 22.7 |
| | 290 | 29 | 27.0 | 25.2 | .25 | 30.0 | 22.5 |
| | 300 | 30 | 27.0 | 24.4 | .25 | 29.0 | 22.3 |
| | 310 | 31 | 26.2 | 24.4 | .25 | 29.0 | 22.0 |
| | 320 | 32 | 26.0 | 24.4 | .25 | 29.0 | 21.7 |
| | 330 | 33 | 26.0 | 23.8 | .25 | 28.0 | 21.3 |
| | 340 | 34 | 25.5 | 23.8 | .25 | 28.0 | 21.2 |
| | 350 | 35 | 25.0 | 23.8 | .25 | 27.0 | 20.9 |
| | 360 | 36 | 25.0 | 23.0 | .24 | 27.0 | 20.8 |
| | 370 | 37 | 24.9 | 23.0 | .24 | 27.0 | 20.7 |
| | 380 | 38 | 24.7 | 23.0 | .24 | 27.0 | 20.6 |
| | 390 | 39 | 24.3 | 23.0 | .24 | 26.0 | 20.4 |
| Adequate flow | 400 | 40 | 24.0 | 22.3 | .24 | 26.0 | 20.0 |
| | 420 | 41 | 23.8 | 21.5 | .22 | 25.0 | 19.8 |
| | 440 | 42 | 23.4 | 21.5 | .22 | 25.0 | 19.6 |
| | 460 | 43 | 23.1 | 21.5 | .23 | 25.0 | 19.3 |
| | 480 | 44 | 22.8 | 21.5 | .23 | 23.0 | 18.9 |
| | 500 | 45 | 22.5 | 20.9 | .23 | 23.0 | 18.8 |
| | 520 | 46 | 22.0 | 20.2 | .23 | 22.0 | 18.5 |
| | 540 | 47 | 21.6 | 20.0 | .23 | 22.0 | 18.4 |
| | 560 | 48 | 21.5 | 20.0 | .22 | 22.0 | 18.2 |
| Erratic flow 2 to 3 inches diameter cone at 1 foot away | 580 | 49 | 21.5 | 20.0 | .22 | 21.0 | 18.0 |
| | 600 | 50 | 21.0 | 20.0 | .23 | 20.0 | 17.9 |
| | 620 | 51 | 21.0 | 20.0 | .23 | 20.0 | 17.7 |
| | 640 | 52 | 20.7 | 20.0 | .23 | 19.0 | 17.5 |

TABLE A-VI.- TEST F — ASCENT WATER TANK WITH WATER DISPENSER/ FIRE EXTINGUISHER, WITHOUT HOKE VALVE - Concluded

| Measurements | Time elapsed, sec | Data point | Descent tank press., psia | Discon. disch. press., psia | Flow-meter press., psid | Water-flow, percent | Hose disch. press., psia |
|---|---|---|---|---|---|---|---|
| Pretest calibrations | | | 59.0 | 56.2 | 0. | 0. | 14.7 |
| Notes: | 660 | 53 | 20.4 | 20.0 | .23 | 19.0 | 17.4 |
| | 680 | 54 | 20.2 | 19.3 | .23 | 18.0 | 17.2 |
| | 700 | 55 | 20.0 | 19.3 | .23 | 17.0 | 17.1 |
| | 720 | 56 | 20.0 | 19.3 | .23 | 17.0 | 17.0 |
| | 740 | 57 | 19.9 | 19.3 | .23 | 16.0 | 16.8 |
| | 760 | 58 | 19.7 | 18.8 | .23 | 16.0 | 16.7 |
| | 780 | 59 | 19.6 | 18.8 | .23 | 16.0 | 17.7 |
| | 800 | 60 | 19.5 | 18.8 | .22 | 15.0 | 17.5 |
| | 820 | 61 | 19.0 | 18.7 | .22 | 14.0 | 16.4 |
| | 840 | 62 | 19.0 | 18.7 | .23 | 14.0 | 16.3 |
| | 860 | 63 | 19.0 | 18.6 | .23 | 14.0 | 16.3 |
| | 880 | 64 | 18.8 | 18.6 | .23 | 13.0 | 16.2 |
| | 990 | 65 | 18.8 | 18.6 | .23 | 12.0 | 15.9 |
| | 920 | 66 | 18.8 | 18.6 | .23 | 12.0 | 15.8 |
| | 940 | 67 | 18.8 | 18.6 | .23 | 12.0 | 15.7 |
| | 960 | 68 | 18.8 | 18.0 | .20 | 11.0 | 15.6 |
| | 980 | 69 | 18.5 | 18.0 | .20 | 11.0 | 15.6 |
| | 1000 | 70 | 18.3 | 17.9 | .21 | 11.0 | 15.5 |
| | 1020 | 71 | 18.3 | 17.9 | .21 | 10.0 | 15.4 |
| No significant flow | 1040 | 72 | 18.2 | 17.9 | .21 | 9.0 | 15.3 |
| Test concluded | | | | | | | |

# APPENDIX B

## METHOD TO DETERMINE QUANTITY OF WATER LEFT IN THE TANKS AT ANY GIVEN PRESSURE

# APPENDIX B

## METHOD TO DETERMINE QUANTITY OF WATER LEFT IN THE TANKS AT ANY GIVEN PRESSURE

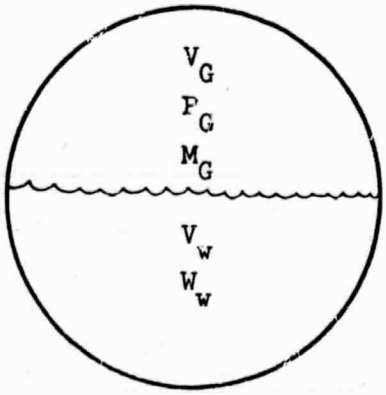
Determination of the water left in the tanks at any given pressure was obtained in the following typical manner.

Volume of gas:

$$V_G = \frac{M_G R T_G}{P_G}$$

Volume of water:

$$V_w = V - \frac{M_G R T_G}{P_G}$$




Weight of water:

$$W_w = \left( V - \frac{M_G R T_G}{P_G} \right) 62.4$$

Where $V$ = total volume

$V_w$ = volume of water

$M$ = mass

$W_w$ = weight of water

$T$ = temperature

$R$ = universal gas constant

62.4 = density of water

G = gas

P = pressure

$M_G$ = constant = initial mass of gas = $M_{G_i}$

$$M_{G_i} = \frac{P_i V_i}{R T_i} \qquad \text{for } N_2 \qquad R = 55.2 \frac{\text{lb-ft}}{\text{lb}_m\ ^\circ R}$$

$$T = 70^\circ F = 530^\circ R$$

$$V_i = 0.2 V_T ft^3$$

$$P_i = 58 \text{ psia}$$

$$V_T \text{ (descent tank)} = 7.14 \text{ ft}^3$$

$$V_T \text{ (ascent tank)} = 0.91 \text{ ft}^3$$

Water capability:

Descent tank — 446 lb

Ascent tank — 56.8 lb

Total — 502.8 ≈ 503 lb

Total water loaded in tanks:

Descent tank — 357 lb

Ascent tank — 46 lb

Total — 403 lb

Therefore,

$$\text{Fill ratio} \quad \frac{403}{503} = 0.803 \text{ for water}$$

$$1 - 0.803 = 0.197 \text{ for gas}, \approx 0.2$$

Descent tank:

$$M_{G_i} = \frac{P_i V_i}{RT_i} = \frac{28(0.2)(7.14)(144)}{(55.2)(530)}$$

$$M_{G_i} = 0.408 \text{ lb}$$

$$V_G = \frac{M_{G_i} RT_G}{P_G} = \frac{0.408(55.2)(530)}{144\ P_G} = \text{ft}^3$$

$$V_G = \frac{83}{P} \text{ ft}^3$$

Therefore, water left in tank (lb)

$$W_w = \left(7.14 - \frac{83}{P}\right) 62.4 \qquad (1)$$

By substituting P in equation (1) by the desired pressure, the weight of the water left in the tank can be obtained. To obtain the weight of the water used, merely subtract the value obtained in equation (1) from the weight of water loaded in the tank.

Similarly, the following equation will furnish the weight of water left in the ascent tank:

$$W_w = \left(0.91 - \frac{10.6}{P}\right) 62.4 \qquad (2)$$

# APPENDIX C

## TEST PROCEDURES

The procedures contained in Appendix C are excerpts from Structures Branch Report 68-ES4-2 entitled Development Test Plan for LM Water Management System for Fire Extinguishing Purposes.

TEST PROCEDURE

Step Description

1 Fill water management simulator, using water fill procedure given in Attachment.

2 Measure differential pressure across descent water tank and hose assembly (see fig. C-2).

3 Calibration of reference point:

a. Record pressure at descent tank instrument port (item 1).

b. Record pressure of item 3.

c. Record differential pressure of item 4.

d. Record flow of flowmeter (0 flow will establish reference point).

e. Record pressure of pressure transducer at outlet end of hose without the water dispenser/fire extinguisher (item 7).

4 Measurement of parameters at flow conditions

a. Slowly open SOV 1 on the WMS until the reading on item 3 stabilizes.

b. Slowly open the Hoke valve on the hose and consecutively establish the following flows:

(1) 0.5 lb/min
(2) 0.85 lb/min
(3) 1.0 lb/min
(4) 2.0 lb/min
(5) 3.0 lb/min
(6) 4.0 lb/min
(7) 5.0 lb/min
(8) 6.0 lb/min
(9) 7.0 lb/min
(10) 8.0 lb/min
(11) 9.0 lb/min
(12) 10.0 lb/min

c. At each of the above flows, record the following:

(1) Descent tank pressure (item 1)
(2) Disconnect discharge pressure (item 3)
(3) Valve differential pressure (item 4)
(4) Hose discharge pressure (pressure transducer)

d. Follow steps b and c, starting with a 10 lb/min flow and decreasing to 0.5 lb/min.

e. Continue steps b, c, and d until the descent tank is empty.

f. Close SOV 1 and the Hoke valve.

5 Measure differential pressure across ascent water tank and hose assembly (see fig. C-2).

6 Calibration of reference point (follow step 3, using item 2 in place of item 1 on the WMS).

7 Measurement of parameters at flow conditions (follow step 4, using item 2 and SOV 2 in place of item 1 and SOV 1 on the WMS).

8 Close SOV 2 and the Hoke valve.

9 Fill water management simulator, using water fill procedure given in Attachment.

10 Measure differential pressure across descent water tank and hose assembly (see fig. C-2).

11 Calibration of reference point:

a. Record pressure at descent tank instrument port (item 1).

b. Record pressure of item 3.

c. Record differential pressure of item 4 (0 $\Delta P$ will establish reference point).

d. Record flow of flowmeter (0 flow will establish reference point).

e. Record pressure of pressure transducer at outlet end of hose upstream of water dispenser/fire extinguisher (item 7).

12 Measurement of parameters at flow conditions:

a. Slowly open SOV 1 on the WMS until the reading on item 3 stabilizes.

b. Slowly open the Hoke valve and maintain 0.7 psia $\Delta P$ on item 4.

c. As tank pressure decreases and while maintaining 0.7 psia $\Delta P$ across item 4, record the following:

(1) Descent water tank pressure (item 1).

(2) Disconnect discharge pressure (item 3).

(3) Flow rate (item 5).

(4) Hose discharge pressure (item 6).

d. Continue step c until the descent water tank is empty.

e. Close SOV 1 and the Hoke valve.

13 Remove Hoke valve (item 4) from the system.

14 Calibration of reference point (follow step 11 except for use of ascent tank in step a and deletion of step c).

15 Measurement of parameters at flow conditions (follow step 12) using the ascent tank (item 2) and SOV 2 in place of item 1 and SOV 1 on the WMS.

NOTE: Since the Hoke valve has been removed from the system, there will not be $\Delta P$ recordings.

16 At completion of test, remove the hose assembly and cap all openings and fittings.

ATTACHMENT

## Fill Procedure

1 The configuration of the water transfer unit (WTU) shall be as follows (see fig. C-3):

a. All valves are closed and the gas system has been vented.

b. The $GN_2$ supply is connected to the MD1 fitting.

c. The water supply line (LDW 430-54379-9) is connected to MD5.

2 The configuration of the WMS shall be as follows (see figs. C-1 and C-2):

a. SOV 1 and SOV 2 shall be closed.

b. The Hoke valve on the hose assembly shall be closed.

3 The configuration of the water servicing manifold (WSM) shall be as follows (see fig. C-3):

a. The water supply hose (LDW 430-54379-9) shall be affixed to the SOV 2 fitting.

b. One water supply line (LDW 430-54379-3) and both $GN_2$ supply lines (LDW 430-54379-1) shall be connected to the WMS.

c. SOV 1 through 12 shall be closed.

d. The $GN_2$ supply line shall be connected to the "T" on the SOV 3 fitting.

4 WTU:

a. Open $V_1$ and $V_5$ and set $G_1$ to read 34 psig by adjusting $PR_2$.

b. Open $V_{10}$ and $V_{11}$.

5 WMS: Open SOV 1 and SOV 2.

6 WSM:

a. Open SOV 4, 6, 7, 8.

b. Start the vacuum pump and open SOV 3.

c. Pull down system to 2.0 mm Hg as read out at vacuum pump.

d. Close SOV 4, 6 and bleed in $GN_2$ to 11.9 psia.

7 WTU:

a. Record flowmeter reading.

b. Open $V_{15}$.

8 WSM: Open SOV 2, 6.

9 a. Let system fill until flowmeter on WTU stops indicating flow (maintain a 34 psig blanket $GN_2$ pressure).

b. Close all valves on WSM.

c. Record flowmeter reading on WTU.

d. Close SOV 1 and SOV 2 on the WMS.

e. Remove all lines from the WMS and cap disconnects.

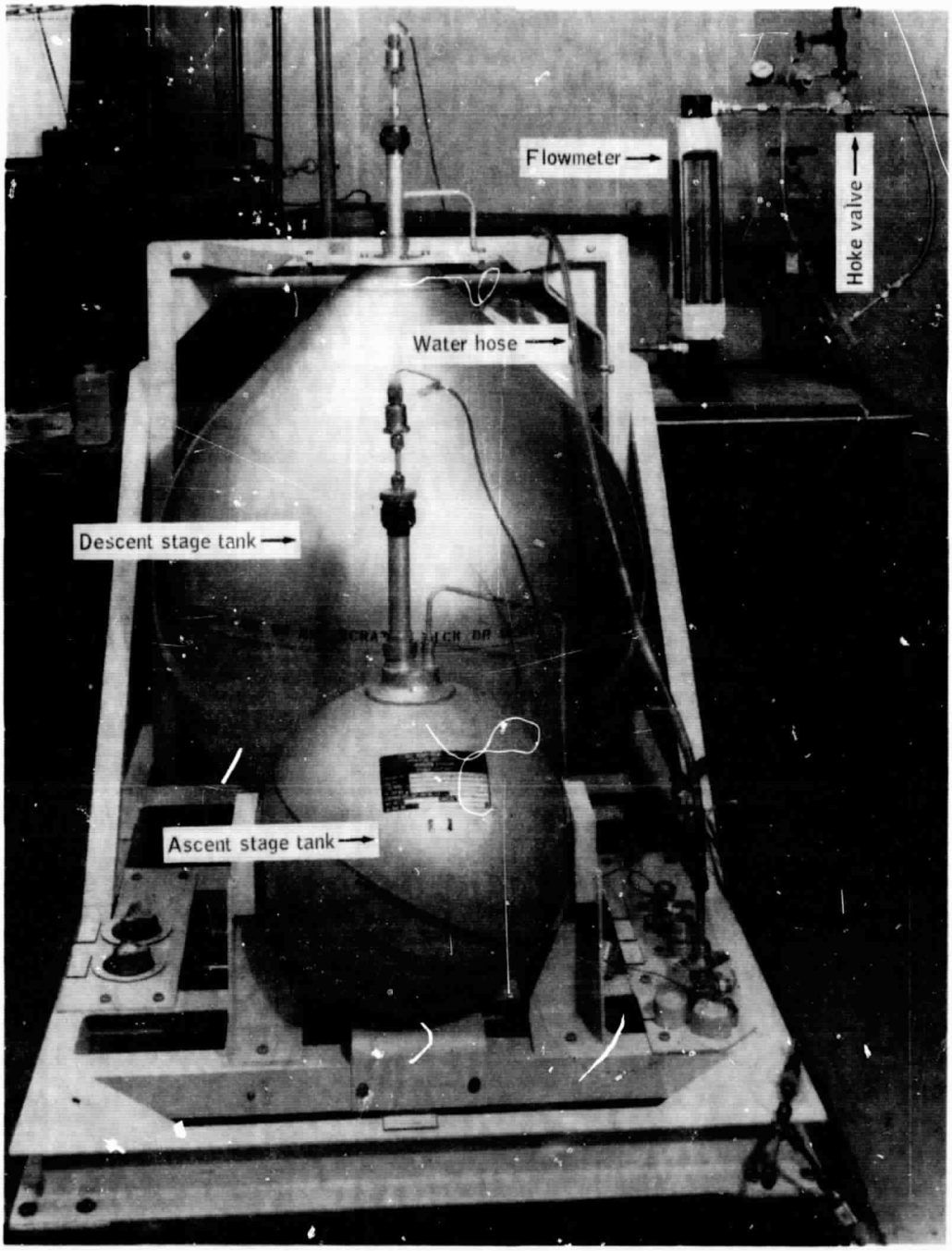



Figure C-1.- The LM Water Management System simulator.

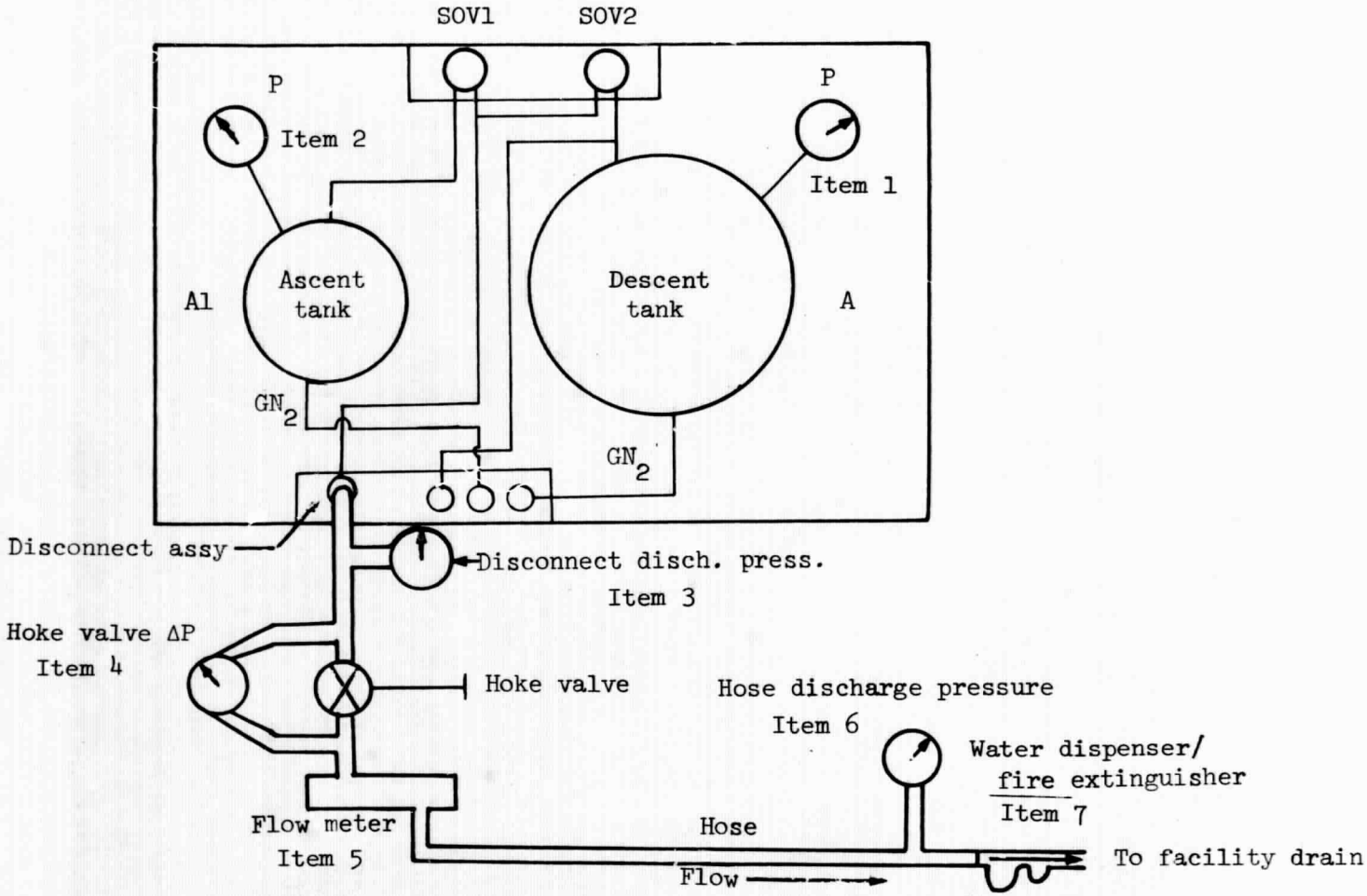



Figure C-2.- Schematic diagram of LM Water Management System simulator.

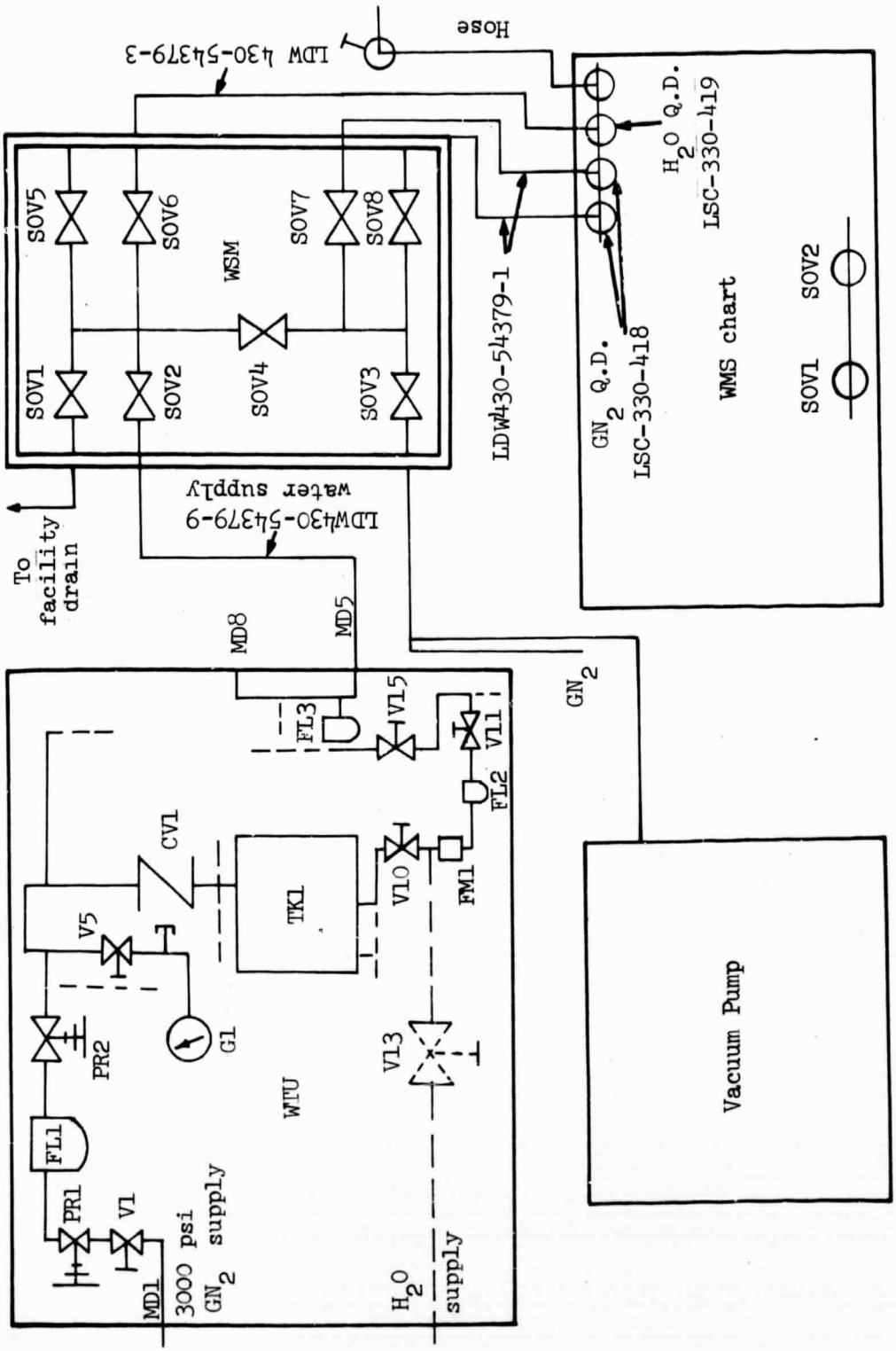



Figure C-3.- Schematic diagram of Water Management System charging unit.